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AMERICAN JOURNAL OF OPHTHALMOLOGY

THIRD SERIES FOUNDED BY EDWARD JACKSON

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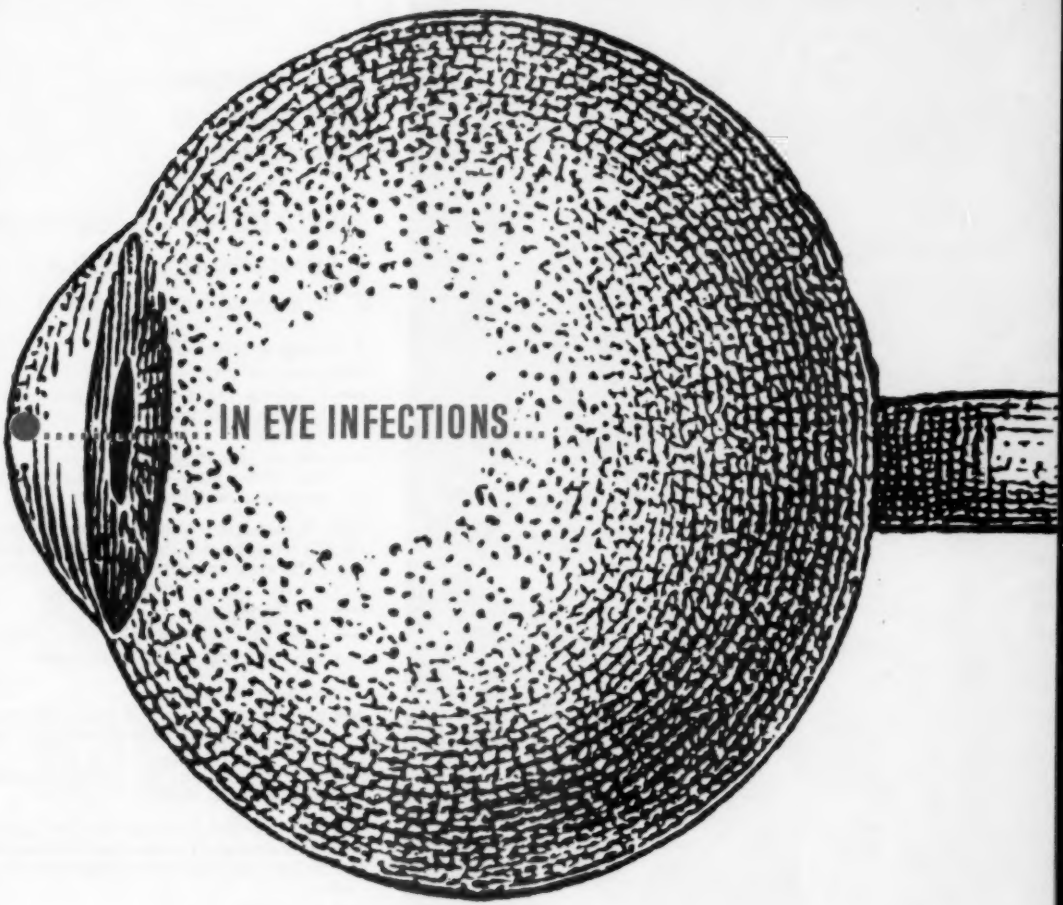

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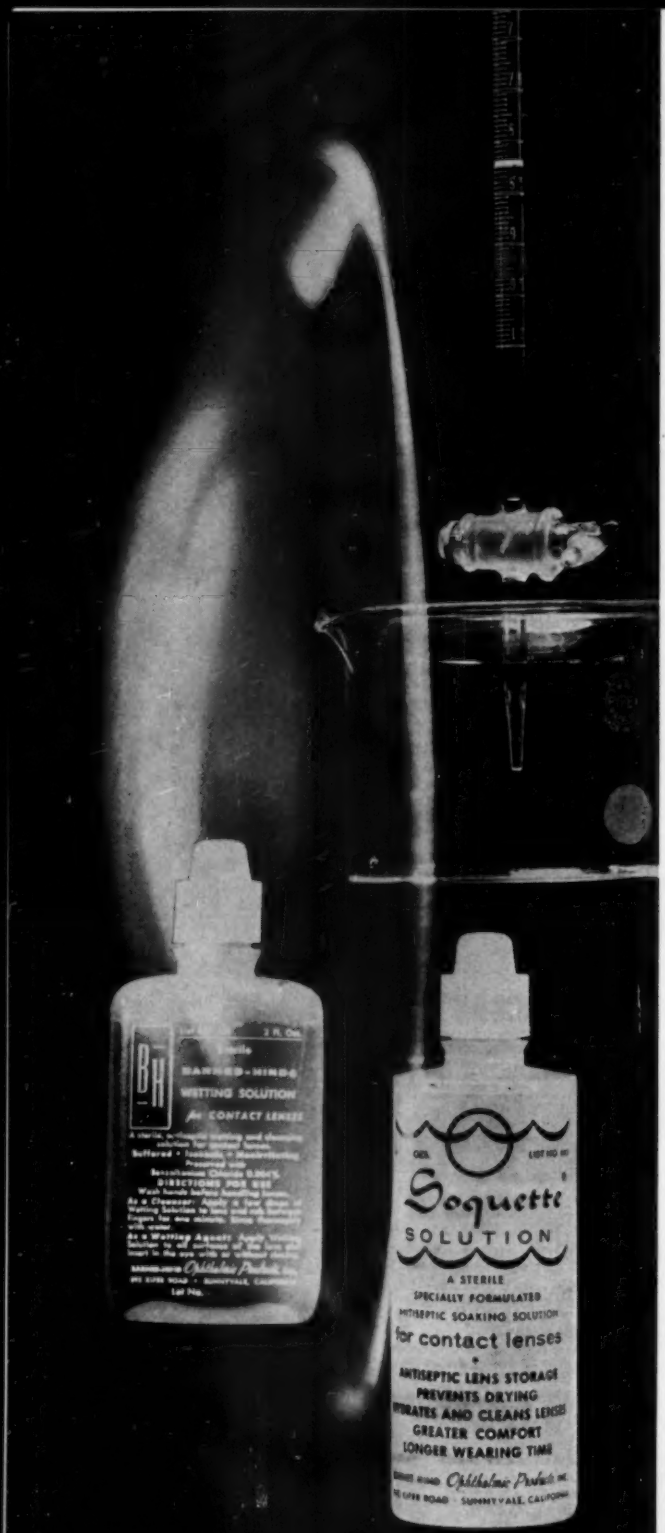

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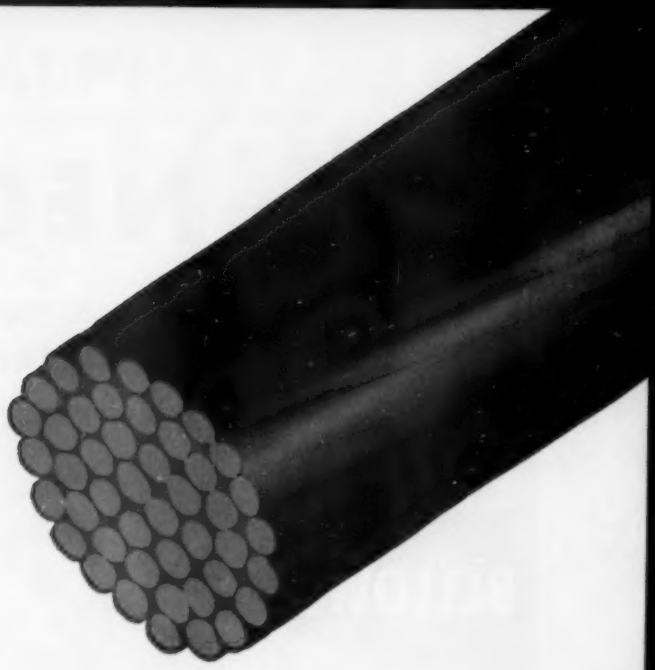

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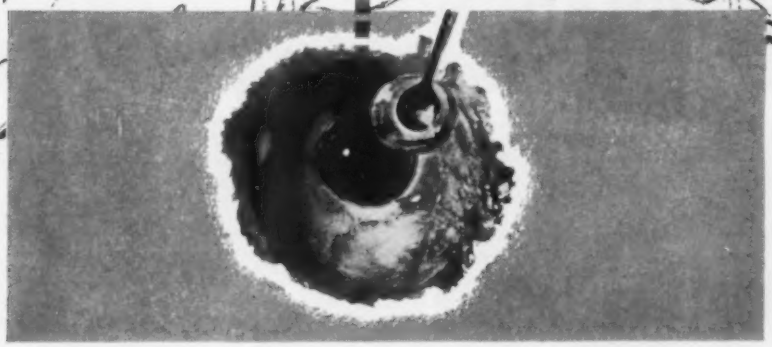

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1. Thorpe, H. E.: Am. J. Ophth. *49*:531-547 (Mar.) 1960. 2. Schwartz, B., *et al.*: Tr. Am. Acad. Ophth. & Otol. *64*:46-54 (Jan.-Feb.) 1960. 3. Cogan, J. E. H.: Proc. Roy. Soc. Med. *51*:927, 1958. 4. Jenkins, B. H.: J.M.A. Georgia *45*:431, 1956. 5. Raiford, M. B.: J.M.A. Georgia *48*:163, 1959. 6. Rizzuti, A. B.: Arch. Ophth. *61*:135, 1959.

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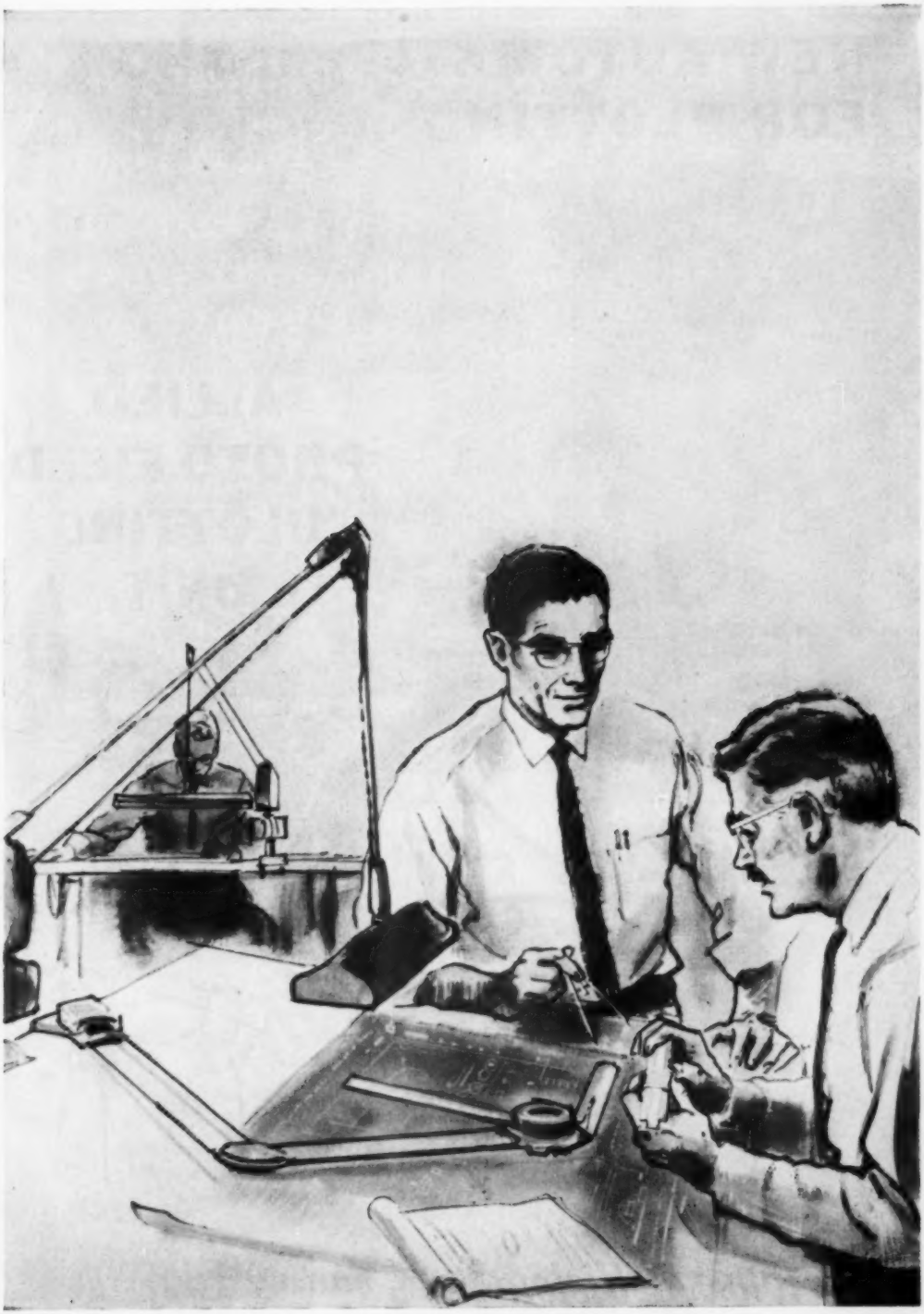

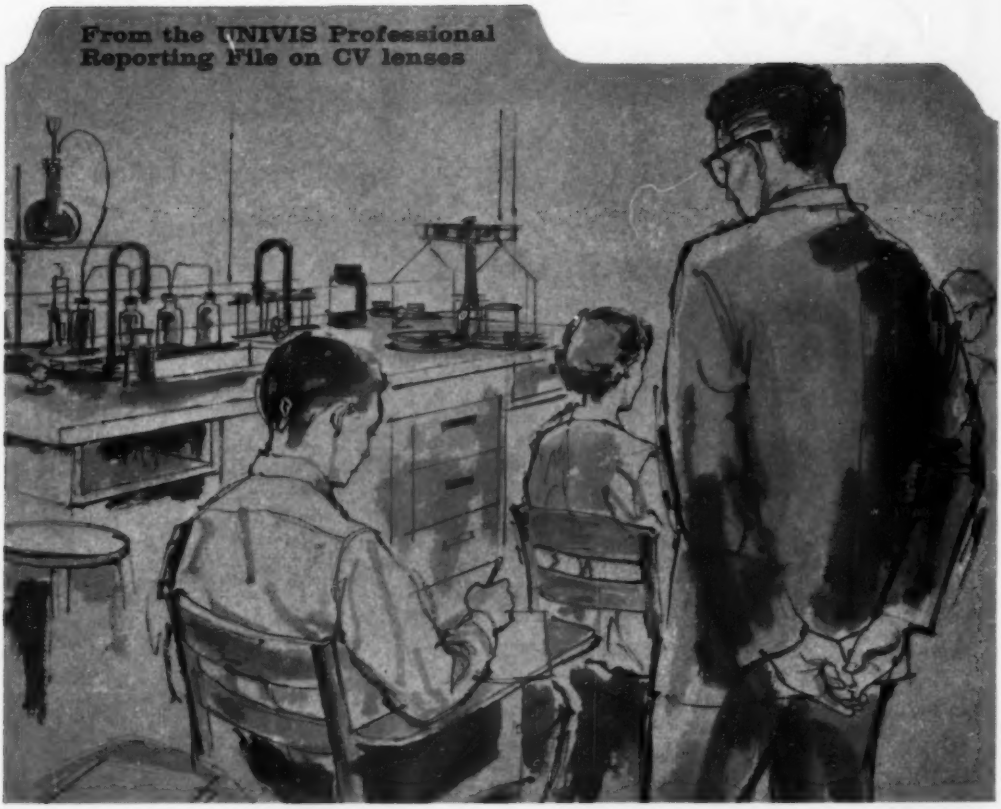

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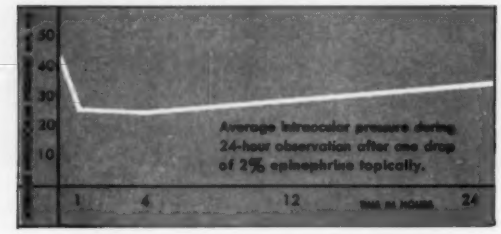

2 "The removal of epinephrine [GLAUCON] topical therapy from 43 eyes previously stabilized and normalized on combined therapy [GLAUCON and a miotic] and permitted to be without this medication for a period of seven days results in a rise in the intraocular pressure ranging from 4 mm. Hg to 31 mm. Hg with an average rise of 11.7 mm. Hg. It is in this group that the greatest number of satisfactory results were noted . . ."

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1. Garner, L. L.; Johnstone, W. W.; Ballintine, E. J.; and Carroll, M. E.: Effect of 2% Levo-Rotary Epinephrine on the Intraocular Pressures of the Glaucomatous Eye. A.M.A. Arch. Ophth. 62:230 (Aug.), 1959.

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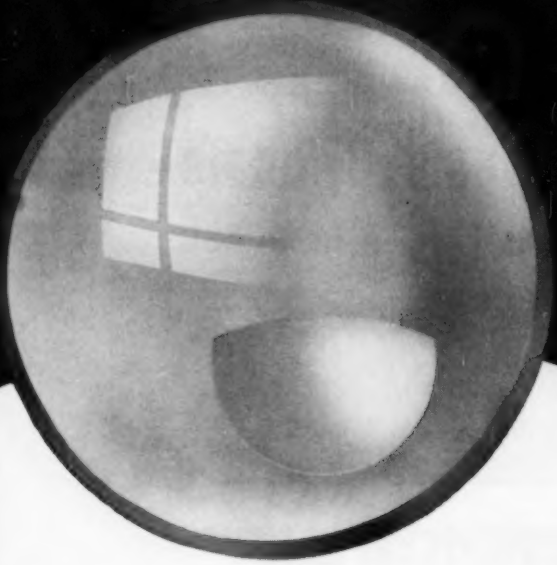

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ABSTRACTS

Anatomy, embryology, and comparative ophthalmology; General pathology, bacteriology, immunology; Vegetative physiology, biochemistry, pharmacology, toxicology; Physiologic optics, refraction, color vision; Diagnosis and therapy; Ocular motility; Conjunctiva, cornea, sclera; Uvea, sympathetic disease, aqueous; Glaucoma and ocular tension 820

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AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 50 NOVEMBER, 1960 NUMBER 5, PART I

SPONTANEOUS VASCULAR REPAIR*

ARTERIOLAR AND VENOUS CILIORETINAL COMMUNICATIONS

BERTHA A. KLIEN, M.D.
Chicago, Illinois

The patterns of spontaneous retinal vascular repair by cilioretinal communications are of interest because of the possibility of creating them therapeutically in a variety of occlusive diseases of the retinal vessels, as has been suggested by Verhoeff.[1] In 1948, Verhoeff reported a case of recurrent hemorrhages into the vitreous successfully treated with diathermy and he believed that cilioretinal venous anastomoses developed in this case at the site of some of the diathermy applications.

Another pertinent case was reported by Lux[2] in a patient with disseminated chorioretinitic scars which were situated mainly along the course of retinal veins, ophthalmoscopically visible retinochoroidal venous anastomoses were discovered within some of them. During an observation period of eight years a new anastomosis was seen to form within an expanding chorioretinitic lesion in this eye. An obliterative retinal venous process in the diseased areas, segmental in character, must be assumed to have been the driving force which gradually effected spontaneous connections with patent ciliary branches.

The presence of cilioretinal communications may also aid in the differential diagnosis between intraocular and retrobulbar vascular disease, and represent a valuable guide in judging the duration of therapy required for occlusive retinal vascular disease.

Cilioretinal communications may be arteriolar or venous in character depending upon the nature of the preceding occlusive vascular disease. The arteriolar variety has been an incidental encounter in my experience, as were some of the venous type; for the latter, however, a diligent search was made in many cases under long-term observation which has paid off by discovery, occasionally, of the earliest signs of anastomotic channels which later became patent collaterals, and which has given an idea of the time element in their formation.

Histologic search for actually established cilioretinal communications, either arteriolar or venous, was not so rewarding, but some information was gained regarding possible steps in their development.

I. CLINICAL OBSERVATIONS

A. ARTERIAL COMMUNICATIONS

CASE 1

M. C., a woman, 46 years of age, was referred to the Eye Clinic of Rush Medical College by the Department of Dermatology where antisyphilitic therapy had been started for the first time. Blood Wassermann was four plus.

The patient had noted diminished vision for the past several years. At the time of her first visit corrected vision was: R.E., 20/40—1; L.E., 20/25+2. The fundi of both eyes revealed an occlusion of the superior temporal arteries. While in the left fundus this artery was occluded to the periphery without compensatory neovascularization, the right fundus showed a number of interesting anastomotic channels, one of them a chorioretinal communication (fig. 1).

There were three different kinds of

* From the Department of Surgery, Section of Ophthalmology, the University of Chicago. This work was supported in part by Grant B-1589 of the National Institute of Neurological Diseases and Blindness, Bethesda, Maryland.

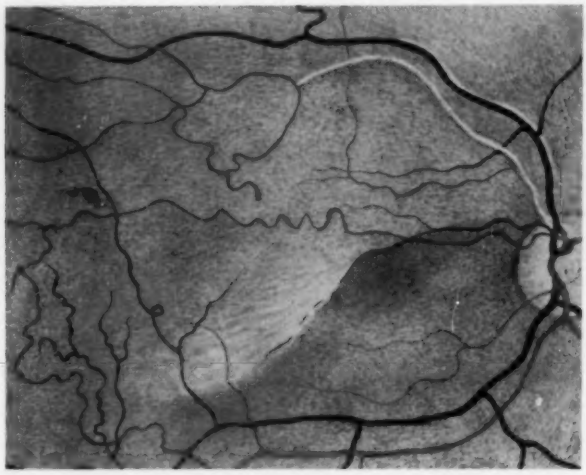

Fig. 1 (Klien). Right fundus in Case 1, a woman 46 years of age, syphilitic endarteritis, arterial cilioretinal communication, antisyphilitic therapy.

spontaneous repair in this case, sending blood supply to the superior temporal sector:

1. From the incompletely occluded first stretch of artery arose a small macular arteriole which sent off a branch almost straight upward to the superior fundus periphery. This branch crossed the occluded portion of the superior temporal artery and therefore is probably a new-formed vessel, since a crossing of artery by artery belongs to the rarest of congenital anomalies.

2. A communication had been established between the inferior temporal artery and the superior macular arteriole, forming a complete circle around the posterior polar region.

3. Just above the horizontal meridian a large artery emerged from behind the retina, penetrating the retina and hooking up with some peripheral branches of the occluded artery, thus supplying the superior temporal periphery. This new arterial branch could represent a communication with the temporal long posterior ciliary artery which runs in the horizontal meridian, or with any of the numerous short posterior ciliary arteries.

The co-existing spotty venous disease in this eye, affecting the superior temporal and the superior macular veins, was probably responsible for the fibrous scarring just temporal to the fovea, which in turn had caused the reduction of central vision in the right eye. It is interesting to note that the inferior nasal sector-shaped defect in the right visual field was much smaller than that in the visual field of the better left eye (fig. 2).

B. Venous communications

Several cases of the finished products of cilioretinal and opticociliary venous collateral formation have been reported and discussed before (Klien [3,4]). The present report will therefore remain confined to such cases in which the communications were observed in the making, or were expected and hoped for and at long last arrived.

Case 2

K. T., a 34-year-old physician, noted an indefinite disturbance of his left vision three days prior to his first visit. He gave the history of a tuberculous pleurisy 10 years ago for which he had received at that time a treatment consisting of bedrest and supportive, nonspecific measures for six months.

At the time of the first examination the vision was 20/20, J1, in both eyes, with a small pericentral scotoma nasal to the point of fixation in the left visual field.

The right fundus was normal. In the left fundus there was slight edema of the optic disc and tremendous engorgement and tortuosity of the retinal

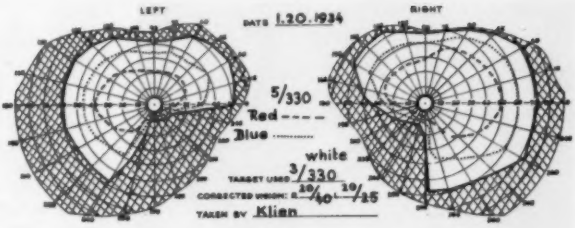

Fig. 2 (Klien). Visual fields in Case 1, bilateral defect corresponding to occlusion of superior temporal arteries. Defect smaller in eye with new anastomotic channels.

veins with nets of fine, new-formed vessels spread over them at many points.

Four large venous loops, with a diameter only slightly smaller than that of normal veins near the disc, projected side by side from the superior temporal quadrant of the disc (fig. 3).

A few small superficial hemorrhages were scattered along the inferior nasal vessels and around the temporal margin of the fovea centralis. The retinal arterioles appeared very slightly attenuated as compared to those of the right fundus.

This fundus picture suggested a very gradual occlusion of the central retinal vein, possibly of inflammatory origin, compensated for so far by formation of almost patent collaterals.

Roentgen pictures of skull and orbit were normal. Angiography was considered but not carried out, since the formation of venous collaterals suggested a more local ocular process rather than an aneurysm of the internal carotid artery in the cavernous sinus, which could be the cause of a slowly increasing venous engorgement per se.

The patient was placed at first on streptomycin and later on isoniazid and para-aminosalicylic acid therapy.

Five months later the left vision was temporarily reduced to 20/25, J2. There were a few larger hemorrhages along the course of the main venous branches, and one superficial hemorrhage encroached upon the foveal region. After absorption of the latter, vision returned to 20/20. At that time a fifth venous loop had formed besides the four previously present, and all of these were larger than before (fig. 4).

The patient was seen again after 23 months when vision in his left eye was 20/20—4, J1, with slight hesitancy due to a minute scotoma nasally to the fixation area.

The picture of the left fundus had changed considerably (fig. 5). The retinal veins were of almost normal caliber again. Most of the fine, netlike neovascularizations had disappeared and of the five collaterals, two (No. 2 and No. 5) had reached the size of normal veins in this region. The other three loops were small and had almost completely receded into the nervehead. There were no hemorrhages. A small, yellowish area temporal to the fovea was interpreted as a glial scar, which was probably responsible for the tiny scotoma.

Visual prognosis in this case is obviously good, the obstruction in the central vein being now completely compensated for by collateral circulation. In addition to that,

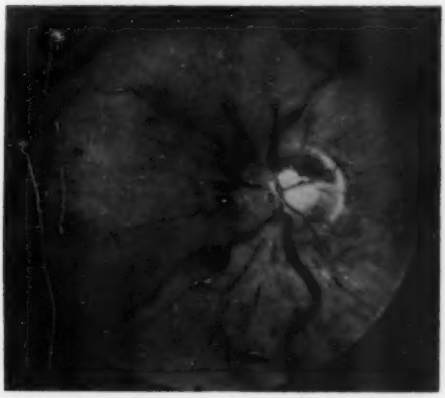

Fig. 3 (Klien). Left fundus in Case 2, a man 34 years of age, spontaneous repair of obstruction of central retinal vein, four new opticociliary venous channels, vision 20/20, antituberculous therapy.

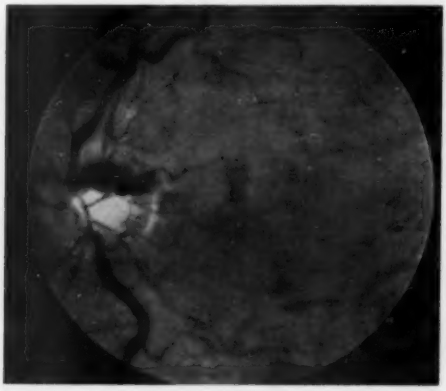

Fig. 4 (Klien). Same fundus as in Figure 3, after five months. A fifth opticociliary vein has appeared, one of the others has doubled its width, venous congestion still marked, vision 20/25.

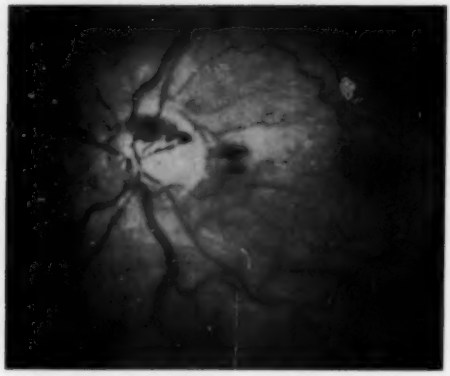

Fig. 5 (Klien). Same fundus as in Figures 3 and 4, after two years. Three of the opticociliary loops have receded, two retain the size of normal veins, venous congestion has disappeared, vision 20/20.

three other potentially patent collaterals are in existence which can be utilized in case of need.

CASE 3

E. W. C., a man 63 years of age, had noted some blurring of his left vision for the past three months. The right vision was 20/15, the left vision 20/29. The striking picture of the left fundus at this time is shown in Figure 6. A year prior to this visit the fundi had been described as normal.

Left eye. From the superior nasal quadrant of the optic disc three venous loops, of the diameter of main venous branches in this region, projected forward above the level of the disc, which otherwise was normal. There was moderate dilatation of the venous retinal tree. No pulsation of the central retinal vein could be elicited by pressure upon the left eyeball. There was a small retinal hemorrhage adjacent to the fovea centralis.

The picture was interpreted as a spontaneous repair of venous occlusion by new-formed branches, or perhaps partly by new-formed vessels and partly by utilization of pre-existing anastomotic channels. The macular hemorrhage and the persisting moderate congestion of the venous tree suggested the need for therapy with anticoagulants to support the natural process of repair.

The right fundus was normal.

Two-and-a-half months after institution of anticoagulant therapy the left vision was reported to be 20/20 again.

The similarities between this case and Case 2 are obvious. Further observation will tell whether the new collaterals in this case will also show the selective changes which could be observed in Case 2.

CASE 4

V. C., a man aged 65 years, noted diminished left vision three days prior to his first visit, at which time it was 20/30+2. Corrected vision in the right eye was also 20/30, the left eye having been his better eye for a long time.

An incomplete occlusion of the left central vein was found and anticoagulant therapy (heparin-Dicumarol) was started immediately.

The patient's cardiovascular system was clinically normal, the blood pressure varied from 132/72 to 150/84 mm. Hg. Aside from a gastric and a duodental ulcer, two and six years ago, respectively, his general health was good.

Within 10 days the left vision had improved to 20/20+2 and remained at this level for three months. At the end of this period the first collateral venous loop was discovered in the superior temporal quadrant of the disc. From that time on, vision gradually diminished until it was 20/40 at the end of another four-month period, at which time two more large venous loops were seen emerging from the superior nasal quadrant of the disc.

Despite this prompt formation of collaterals, three respectively, seven months after the first visual disturbance, and continuous anticoagulant therapy with no escapes above the therapeutic range of prothrombin levels, the left vision continued to fail. At the end of 10 months fresh hemorrhages again appeared and vision dropped to 20/60 and 20/100 shortly thereafter.

Twenty-nine months after the onset of the partial occlusion, remaining left vision was 12/200. Edema of the disc, venous congestion, and hemorrhagic imbibition of the retina had increased, indicating that in this probably sclerotic, irreversible occlusion either the speed of collateral formation had been no match for the speed with which the obstructive process developed, or that the disease process had

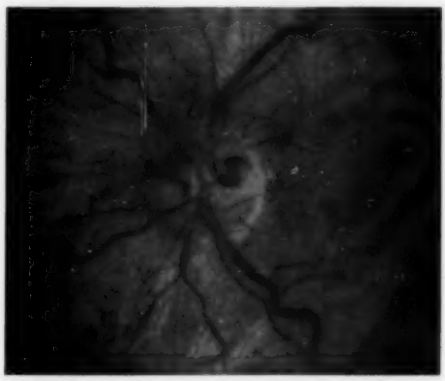

Fig. 6 (Klien). Left fundus in Case 3, a man 63 years of age, spontaneous repair of obstruction of central retinal vein. Three opticociliary collaterals, vision 20/29, after three months of anticoagulant therapy, 20/20.

spread to include also the collateral pathways.

One pleasant surprise in this case was the improvement of the corrected right vision from the original 20/30 to 20/15.

CASE 5

W. Z., a man 54 years of age, complained of loss of vision at some time during the past year. Being an occasional hunter he had used the right eye for aiming a year ago but could not do so any more. Recently he was aware of some disturbance of the left vision also. His right vision was 20/200, the left vision 20/15. There was a small pericentral scotoma in the left field.

Right fundus. The optic disc was normal in color and outline, the retinal veins were slightly congested and a fine network of new-formed vessels covered large portions of the inner retinal surface in the macular region and along the course of the large veins. The utmost fundus periphery still showed numerous flame-shaped hemorrhages. There was a retinal hole in the macula.

In the upper half of the disc three large opticociliary veins were visible, serving apparently as efficient collateral pathways (fig. 7).

Left fundus. The disc was hyperemic and slightly edematous. There was tremendous dilatation of the retinal veins (fig. 8) and numerous tufts of new capillaries had formed along their course. In the macular region and temporal to it there were scattered microaneurysms and small deep hemorrhages.

The arteriolar retinal tree in both eyes showed a slight, diffuse narrowing but otherwise appeared to be normal.

The ophthalmoscopic picture was interpreted as a spontaneous repair of an occlusion, or partial occlusion, of the right central retinal vein with permanent visual damage due to a macular hole, and an impending occlusion of the left central vein.

Physical examination was entirely noninformative. Blood pressure recordings, glucose tolerance tests and renal function were normal. The inflammatory survey was negative.

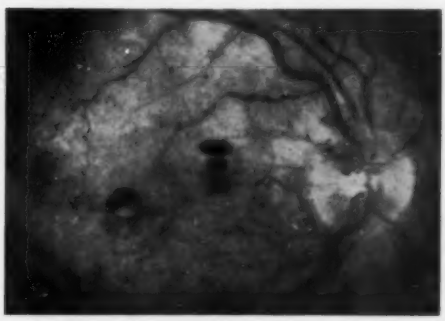

Fig. 7 (Klien). Right fundus in Case 5, a man 54 years of age, spontaneous repair of obstruction of central vein. Three opticociliary collaterals in upper half of disc. Hole in macula, vision 20/200.

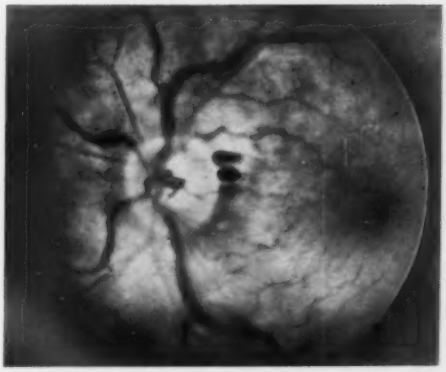

Fig. 8 (Klien). Left fundus in Case 5, incipient obstruction of central retinal vein, vision 20/14; steroid therapy and, later, anticoagulants.

Prednisone therapy was instituted and continued for eight and one-half months. During the first six months of this period the left vision remained 20/15 and the scotoma was no longer noticed by the patient, although objectively the venous congestion did not lessen.

During this this time a percutaneous renal biopsy and muscle and skin biopsies were carried out.

The renal biopsy revealed an unusual venous and, to a lesser degree, arteriolar disease, specifically of the afferent preglomerular arterioles and corresponding veins, with occlusive tendencies.

Seen with the electron microscope a smallest arteriole had a thick homogeneous wall with a tiny lumen which was filled with one endothelial cell of normal appearance.

Muscle and skin biopsies revealed similar changes of the corresponding size of arterioles and venules.

In this connection it is interesting that the patient has a twin brother who lost the sight of both eyes from occlusion of the central retinal veins. Unfortunately it has been impossible so far to obtain information on the twin's vascular system in general.

For the following two and one-half months the left vision remained 20/20 with one temporary impairment to 20/25. After this period there was a rapid reduction of left vision (within five days) to 20/40. The patient was then admitted to the hospital for initiation of anticoagulant therapy. Heparin restored the vision to 20/20—4 within a few days and the patient was discharged to ambulatory therapy with Dicumarol under control of a local hospital.

Stabilization of the prothrombin level has been extremely difficult in this patient and escapes above the therapeutic level have been numerous and prolonged.

During the first three months of ambulatory therapy, left vision diminished by slow stages to 20/60, 20/80, and 20/100. In the left fundus edema of the optic disc and venous congestion were in-

creasing and large hemorrhages appeared along the main vessels.

About this time, that is 12 months after the first visual disturbance in this eye was noted, the first sign of a collateral pathway in the form of a large venous loop appeared in the upper half of the disc. During the following two months, two more opticociliary branches appeared beside the first loop in a location almost identical to those in the other eye. At this time vision began to improve again and after four months reached the 20/60 level.

There was a noticeable decongestion of the venous tree while the new venous loops became more prominent (fig. 9).

Prednisone therapy was resumed in addition to the anticoagulant treatment, with the intention of reducing the extent of the fibrovascular membranes on the inner retinal surface and avoiding severest macular damage.

At the present time, two years and a half after the initial visit, venous congestion in the left fundus and all hemorrhages have disappeared, the optic disc is normal, two of the three opticociliary veins are prominent and well filled and the tufts of new capillaries along the veins have disappeared. The macular region, however, still shows a few microaneurysms, a fibrovascular rete, and incipient microcystic degeneration.

Comment. In this patient the slow formation of collateral pathways, which became visible 12 and 14 months after signs of venous circulatory impairment were already present, points to formation of new channels rather than to utilization of preformed vessels.

Renal, skin and muscle biopsies showed the retinal vascular disease to be part of a systemic disease, apparently noninflammatory in character. The thrombotic tendency revealed in these biopsies suggested anticoagulants as the therapy of choice.

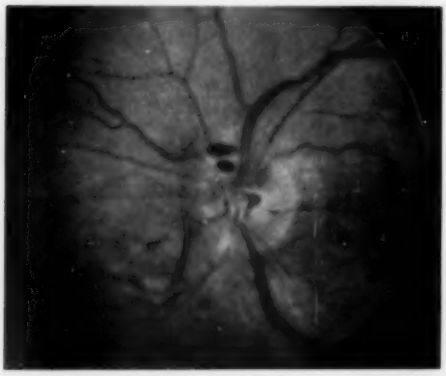

Fig. 9 (Klien). Same fundus as in Figure 8, after 14 months. Three opticociliary collaterals have appeared in upper half of disc, venous congestion has diminished, vision 20/60.

The presence of microaneurysms and nets of neovascularization in the left fundus before any visual damage due to occlusion of the central vein had occurred, pointed to capillaries and smallest venules as the initial site of the disease.

CASE 6

B. S., a man 54 years of age, had noted some disturbance of his left vision for three months prior to his first examination. At that time the right vision was 20/20, the left vision 20/25. An early open-angle glaucoma with Schiøtz pressure of: R.E., 31.0 mm. Hg and L.E., 30.0 mm. Hg was discovered.

Fundi. The right optic disc was normal. On and near the disc there were scattered tufts of neovascularization along and over some of the veins. The venous tree was, however, of normal caliber while the arterial tree showed a slight generalized attenuation.

The left disc was hyperemic. There was marked congestion of the retinal veins over many of which nets of neovascularization were spread. Flame-shaped hemorrhages were scattered over most of the fundus, suggesting an incipient occlusion of the central vein. A slight, diffuse narrowing of the arterial tree appeared to be present also in this fundus.

At the temporal border of the disc a large opticociliary venous branch raised hope for an effective collateral circulation. During the following months, this opticociliary branch became very large while the venous congestion gradually lessened.

Certain similarities in the fundi of this patient and in those of Case 5 suggested the possibility of a more widespread venous disease and a percutaneous renal biopsy was performed.

In the biopsied material an old, inactive renal thrombophlebitis with an old focal thrombotic occlusion of a small vein was found. The thrombus was partially recanalized. Some small veins and arteries in the neighborhood of the occluded vessel showed focal hyaline thickenings of their intimas.

Seven glomeruli present in the biopsied material were uniform in size and appearance with only minor focal thickenings of the basement membranes of the capillary loops near the axial portion. The tubular pattern was normal without evidence of focal fibrosis except in the area of old thrombophlebitis.

A muscle biopsy in this patient, performed elsewhere, was reported as normal.*

The physical findings were noninformative; the

* For some of the clinical data of Case 6 I am indebted to Dr. Lawrence Lassiter.

blood pressure was 115/85 mm. Hg. Skin tests performed as part of an inflammatory survey were mildly positive to the first strength of purified protein derivative (PPD), toxoplasmin and brucellin.

The patient was treated with oral cortisone for several weeks and water-soluble citrus flavonoids with ascorbic acid (CVP) for several months. Anticoagulants were withheld because it was felt that the retinal venous disease was possibly of an inflammatory nature which might respond to other forms of therapy. The glaucoma was completely controlled with a two-percent solution of pilocarpine and Diamox.

After six months the neovascularizations in each eye had disappeared, the right vision had remained 20/20, the caliber of the left retinal veins had returned to normal and the left vision had become stabilized at 20/40. The opticociliary vein in the left disc has become very large and gives the impression of aiding materially the venous circulation in this eye.

Comment. The presence of an apparently effective collateral channel as early as three months after the first signs of visual failure, suggests utilization of a preformed rather than a new-formed collateral branch.

As in Case 5, venous retinal disease in this patient was bilateral. Its indications in the right eye, whose vision remained normal, consisted of scattered fibrovascular proliferations indicative of obstruction of capillaries or smallest venules, and of a slight generalized attenuation of the arteriolar tree which could be due to reflex spasm from the incipient but extensive retinal venous disease.

As in Case 5, the disease started apparently in the smallest venules or capillaries and began to involve the larger venous branches and the central vein after a duration of many months.

In contradistinction to Case 5, the good response to anti-inflammatory therapy and the discovery by renal biopsy of a healed renal thrombophlebitis, make the inflammatory nature of the venous disease in this case probable.

In both cases, 5 and 6, renal biopsy aided materially in establishing a sound therapeutic management.

II. Histologic observations

A. Cilioretinal communication

One instance of an established cilioretinal communication was encountered in the right eye of a 52-year-old man with advanced essential hypertension (blood pressure 260/160 mm. Hg), who had lost this eye from secondary glaucoma after occlusion of the central retinal vein. The eye was removed seven weeks after onset of the pain and an unknown period after the vascular accident.

A congested venous branch could be followed from the nasal side of the disc into the outer layers of the retina and through Bruch's membrane into the layer of large vessels of the choroid (fig. 10). At the point of exit through Bruch's membrane the edges of the membrane were turned outward. Proliferated pigment epithelial cells and cuticular substance were heaped up around the vessel just inside of the break. No other ruptures nor any obvious degenerative processes of the membrane were found elsewhere.

While there was marked retinal arteriolar sclerosis with extensive hyalinization of the vessel walls, such as characterizes late essential hypertension, the choroidal vasculature appeared to be entirely normal.

B. Aberrant retinal vessels

In a variety of retinal vascular disease aberrant arterioles or veins were encountered which, growing backward through the avascular layers of the retina, could be the first step toward cilioretinal communications.

Figure 11 shows an aberrant artery in the right eye of a man 71 years of age, who had bilateral pseudo-exfoliation of the lens capsule and a secondary glaucoma in this eye. The patient was also receiving antisyphilitic therapy for the first time in his life. The blood pressure was normal.

The marked degree of retinal arteriosclerosis of the obliterating, endarteritic type was suspected to be of syphilitic origin.

The aberrant vessel, found inferior temporally to the macula, coursed backward, causing a circumscribed interruption of the nuclear layers, the external limiting membrane, and the neuroepithelium.

The pigment epithelium of this area was

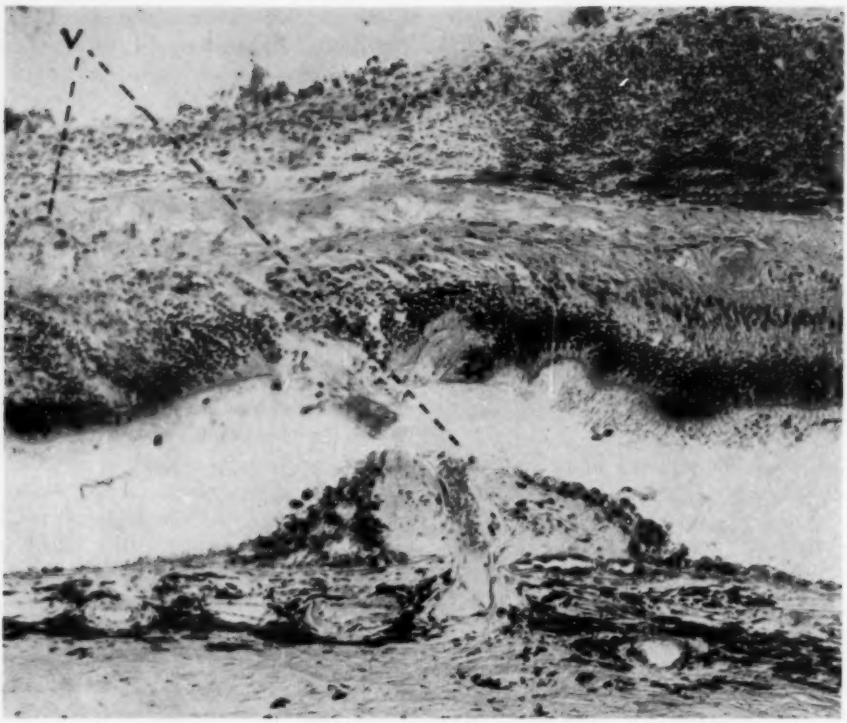

Fig. 10 (Klien). Right eye of a man 52 years of age, lost from secondary glaucoma after occlusion of central vein, advanced essential hypertension. (V) Venous cilioretinal communication, edges of Bruch's membrane everted. (×125.)

slightly irregular, some of its cells having lost part of their pigment content and being somewhat larger than the rest (hydropic?). On the other side of the intact Bruch's membrane at this point there was a localized area of hyperemia of the choriocapillaris. A medium-sized arteriole, surrounded by the congested capillaries, closely approached the outside of the membrane.

No actual cilioretinal communication was found in serial sections of this area but the unusual vascular findings on each side of Bruch's membrane could have been preparatory to it. The distance of the anomalous choroidal arteriole from either a long or short posterior ciliary artery could not be determined.

Figure 12 illustrates another aberrant arteriole in the left eye of a woman 70 years of age, with generalized arteriosclerosis, senile dementia, a blood pressure varying from 132/82 to 150/98 mm. Hg, and a bilateral occlusion of the central retinal vein.

There was marked retinal angiosclerosis of the senile involutionary type characterized mainly by thickening of the adventitia and fibrosis of the muscularis. The aberrant arteriole, which was located in the horizontal meridian temporal to the macula, bent sharply backward, penetrating the nuclear layers, the external limiting membrane and the neuroepithelium, reaching contact with Bruch's membrane while the pigment epithelium was slightly inverted along its wall. No unusual vascular findings were observed in the choroid, which appeared entirely normal. The aberrant retinal vessel was located in the

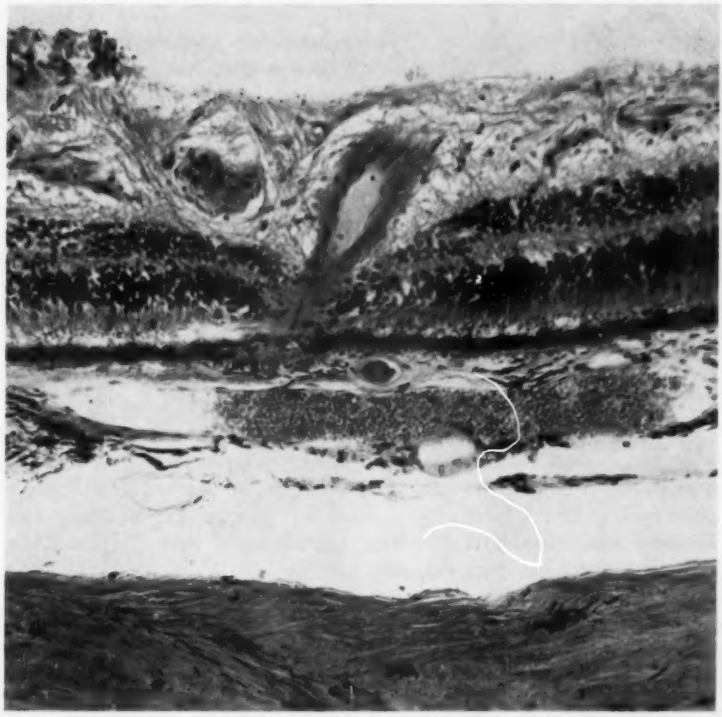

Fig. 11 (Klien). Right eye of man 71 years of age, lost from secondary glaucoma in pseudo-exfoliation of lens capsule. Syphilitic endarteritis. Aberrant retinal arteriole inferior temporally to macula, area of hyperemia of choriocapillaris, and choroidal arteriole approaching Bruch's membrane opposite aberrant retinal vessel. (×160).

general region of the temporal long posterior ciliary artery.

New formation of several small arterioles in the avascular layers of the retina along the sclerotic superior temporal artery was found in the left eye, obtained post mortem, of an 85-year-old woman. One of these arterioles had perforated the external limiting membrane and had pushed several rod and cone nuclei outward (fig. 13).

In Figure 14 an example of an aberrant venous branch is shown, found in the right eye, obtained post mortem, of a man 72 years of age. There was pronounced retinal arteriosclerosis which had led to a complete obstruction of the inferior temporal artery in this eye. At the site of the new venous branch there was considerable venous com-

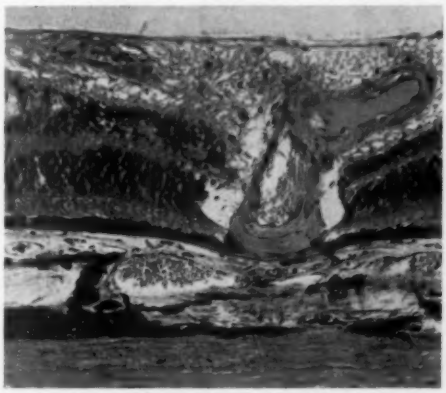

Fig. 12 (Klien). Aberrant arteriole temporal to macula in left eye of a woman 70 years of age. Eye lost from secondary glaucoma after occlusion of central vein. Generalized arteriosclerosis, senile dementia. (×160.)

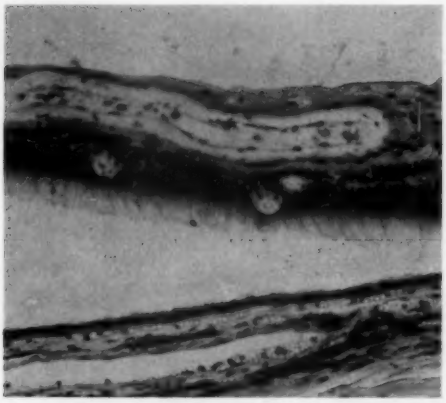

Fig. 13 (Klien). Sclerotic superior temporal artery with new-formed arterioles in outer avascular layers of retina in left eye (post mortem) of woman 85 years of age. (×145.)

pression. The new vein was at first running straight backward, pushing the external limiting membrane outward and dislocating a number of rod and cone nuclei, then turned slightly and coursed for a considerable stretch through the outer avascular retinal layers. No disturbance of the pigment epithelium or of the choroidal vasculature was found in this case.

COMMENT

In slowly obliterative arteriolar retinal disease, new formation of small vessels or a rerouting of larger arterioles into an aberrant course through the avascular layers of the retina was observed, similar to the events occurring in obstructive venous disease.

While an actual arterial cilioretinal anastomosis was found only in a clinical case (fig. 1), the occurrence of aberrant arterioles in the general region of the long posterior ciliary arteries and in one case (fig. 11) the presence of an anomalous choroidal arteriole within a hyperemic capillary bed just opposite the aberrant retinal vessel on the other side of Bruch's membrane, suggested conditions which might facilitate the formation of such communications.

A more purposeful new-formation of vessels to effect patent anastomotic opticociliary or cilioretinal channels in slowly occlusive venous and, in rarer instances, arterial disease may differ only in degree from the disordered retelike neovascularizations which characterize the venous obstructive syndrome as described by Wise.[5]

The stimulus for both types of vascular new-formation could be the same, that is, an irreversible, slowly progressive vascular obliteration with chronic relative anoxia, leading to reappearance of Michaelson's vasoformative factor.

This factor could act simultaneously on retinal and choroidal circulation and, perhaps depending upon favorable anatomic relations such as proximity of large posterior ciliary arteries or of venous opticociliary branches, and upon the integrity of the choroidal vasculature, produce effective collaterals rather than disordered neovascularization.

Cilioretinal, in contradistinction to opticociliary, communications have to overcome the resistance of the intervening membrane of Bruch. Conditions rendering the membrane fragile, inviting breaks and fragmentation such as senile calcifications and myopia (see Klien,[3] fig. 15), would certainly facilitate retinociliary communications. The main aim

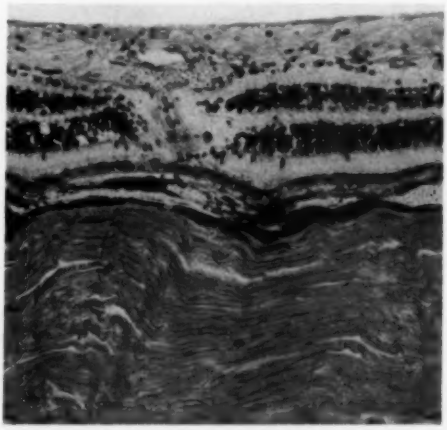

Fig. 14 (Klien). Aberrant vein in outer avascular retinal layers opposite an arteriovenous crossing in right eye (post mortem) of a 72-year-old man. Pronounced retinal angiosclerosis. (×140.)

of therapeutic intervention with the purpose of such communications in mind would be a localized destruction of Bruch's membrane by judiciously placed diathermy or, possibly, photocoagulation.

Summary and Conclusions

Slowly obliterative venous and, in rarer instances, arteriolar retinal disease may lead to spontaneous formation of effective collateral cilioretinal or opticociliary channels.

Evidence of such collateral formation deserves immediate support of the natural process by anticoagulant therapy, whether the obstructive process is arterial or venous, unless an inflammatory pathogenesis of the vascular disease is probable.

Percutaneous renal biopsy, carried out in two of the cases reported here, proved to be a valuable guide in establishing a sound therapeutic management, and should become a more frequently used part of our armamentarium for differential diagnosis of retinal vascular disease.

Some insight was gained concerning the time element involved in the formation of effective, clinically visible venous collaterals. They were observed as early as three months and as late as 14 months after onset of the venous obstruction. Keeping in mind the possibility of such late, and still effective, collateral formation should prevent premature discouragement and untimely interruption of long-term anticoagulant therapy, and suggests a rationale for periodic use of steroids during the waiting period to reduce to a minimum the fibrotic residua of stasis, edema, and hemorrhage of the macular region.

The presence of new venous anastomotic channels is a valuable differential diagnostic sign pointing to a local cause of venous circulatory impairment. In venous congestion and hemorrhagic retinal disease due to back pressure from pathologic processes behind the eyeball, in the region of the cavernous sinus, and so forth, no stimulus for local neovascularization exists.

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EXPERIENCE WITH THE JOSÉ BARRAQUER METHOD OF EXTRACTING A DISLOCATED LENS*

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Introduction

The management of a patient with a dislocated lens is still an extremely controversial subject. There is no general agreement among authorities in the current literature and standard textbooks concerning the indications for the surgical removal of a dislocated lens, and there is much confusion and disagreement as to which of the many techniques available is most desirable once surgical treatment has been decided upon. These factors, combined with the severe hazards and frequent disastrous results fol-

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lowing operation in such cases, have caused the average ophthalmologist to approach the problem with understandable hesitancy and fear.

The technique which we will present is essentially that as recently described by José I. Barraquer[1] in which a double-pronged needle is passed through the pars plana to trap and support the dislocated lens. It is applicable both to luxations into the anterior chamber or vitreous as well as to subluxations, and can be used in all age groups for dislocations of any etiology, whether traumatic, spontaneous, or congenital. We feel that the many advantages which this method has to offer should make it the procedure of choice in almost all cases in which extraction of the dislocated lens is indicated.

The purpose of this paper is threefold: (1) to describe the operative technique which we have used in 20 consecutive cases; (2) to analyze our postoperative results and complications, as well as the effect of lens removal on the intraocular pressure in those cases with glaucoma; and (3) to list and discuss what we consider to be the present-day indications for the removal of a dislocated lens.

Review of previously described techniques

The large number of methods described in the literature for removing the dislocated lens seems to attest to the fact that none has been entirely satisfactory. Many authors have recognized the need for some type of support to prevent the subluxated lens or the lens luxated into the anterior chamber from falling back into the vitreous during the extraction; as well as the need for getting the lens which is luxated in the vitreous into an accessible position from which it could be easily removed.

We certainly claim no originality for the procedure which we are presenting since we learned of this basic technique from José I. Barraquer,[1,2] who in turn modified a technique of inserting two straight dissecting needles behind the lens, which had been taught him by his father. José Barraquer inserts a double-pronged needle behind the lens through the pars plana as a support, both for subluxated lenses and for those luxated into the vitreous. In those cases in which the lens is floating freely in the vitreous he places the patient in a prone position so that the lens can settle forward, behind the pupil, where it can subsequently be trapped by the insertion of the needle. This holds the lens in place when the patient is returned to the supine position for the actual extraction of the lens. His needle, manufactured by Grieshaber, is held at a 45-degree angle by any standard needle holder during its insertion and withdrawal. In a series of 16 cases he found the postoperative course free of complications except for development of a late retinal detachment in one case.

Neither we nor Barraquer were aware that Agnew[3] had previously described a technique before the American Ophthalmological Society in 1885 which was very similar to that of Barraquer in many ways. Agnew described the successful use of a double-pronged needle or "bident" (fig. 1), which he had fashioned from two knife-needles, as a support for a subluxated lens. Following this report there was a brief flurry of interest in his method in the literature. Some six cases were reported by four different authors in which the Agnew bident was used with varying degrees of success.[4-7] All these surgeons, including Agnew himself, used this method only for subluxations and only with the patient in the routine supine position. They apparently did not consider turning the patient with a lens in the vitreous into the prone position so that the lens could be trapped in an accessible position behind the pupil. There was some opposition to Agnew's method before the turn of the century

Fig. 1 (Calhoun and Hagler). Agnew's "bident" and holder. (Tr. Am. Ophth. Soc., 4:69, 1885).

on the grounds that it was too traumatic to the ciliary body.[8, 9] These criticisms must have been effective because this method ceased to be mentioned in the literature after 1892 until the present time. Dr. Agnew's prediction that his instrument might be "relegated, after further trial, to the list of curiosities of ophthalmic practice"[8] has turned out to be quite true.

As far back as 1853, Dixon[10] described a method of inserting two straight needles through the ciliary body behind the lens after first placing the patient in the prone position so the luxated lens could be trapped behind the pupil. Since this was long before the day of intracapsular extractions he simply performed a discission after the lens had been trapped by the needles.

Several other surgeons besides Barraquer and Dixon have utilized the prone position as an aid in removing lenses luxated into the vitreous. However, since they did not use any support behind the lens they could not return the patient to the supine position and had to open the eye and deliver the lens with the patient remaining in the prone position. It is not surprising that all reported vitreous loss in their cases.[11-13]

Practically all authors mention the possibility of trapping luxated lenses in the anterior chamber with miotics so that they can be easily removed. However, we could find few cases reported in which this method actually was successful..

Instead of passing an instrument behind the lens as a support, several authors[14-16] recommend transfixing the subluxated or anteriorly luxated lens by inserting a needle or knife through it prior to its extraction with a loop. Knapp,[17] Chandler,[18] Franceschetti,[19] and Barraquer[1] all stress the fact that in children with a subluxation the loose lens should be transfixed prior to performing a discission to prevent the lens from being inadvertantly pushed into the vitreous.

From a review of the English literature it is quite apparent that methods using the lens loop or spoon are the most popular of all. The first reference we could find was by Critchett[20] who, in 1895, reported the successful extraction of a subluxated lens with the aid of a lens loop. Many others[21-26] have strongly recommended the use of the loop or vectis both for subluxations and luxations, and the seeming preference for this method is exemplified by Kirby's statement in his textbook, that "if the lens is luxated into viscid or semiviscid vitreous there seems to be no option but to use the loop or the spoon."[27]

As mentioned earlier, Higgins,[12] Webster,[13] and Brachen[11] placed the patients in the prone position before using the loop in lenses luxated into the vitreous in order to help minimize the obvious traumatic procedure of fishing blindly in the vitreous for an elusive and freely movable lens. Irvine,[28] performs a loop extraction combined with a conjunctival pocket flap, and others use the loop only after the lens has first been transfixed[14-16] or supported.[29] Paine[30] was the first to recognize the need for adequate visualization in loop extractions from the vitreous, and Hildreth[31] introduced the ultraviolet light for increasing the visualization in these cases. Vail[32] and Wiener[33] both prefer the solid-bladed Smith spatula to the loop.

Several miscellaneous methods have been described and used with some degree of success. Verhoeff[34] introduced a method of floating the luxated lens up into the pupillary space where it could be easily removed by irrigating the vitreous chamber with a stream of normal saline. Iliff,[35] uses two erisophakes in a similar method based on the same principle. Smith[36] recently reported a case in which the lens was removed successfully from fluid vitreous by grasping it with a single erisophake after Verhoeff's method had failed. Fixation and extraction of the lens by diathermy electrocoagulation has been recommended by Gardilcic,[37] Arruga,[38] and Stallard,[16] both for subluxations and luxations. Stallard, recognizing the difficulties and dangers attendant with loopings from the vitreous, advocates a posterior transscleral route for the removal of

lenses luxated into the vitreous cavity.

Certainly the most interesting, and probably the simplest method of all is that advocated by Bull[8] in 1889 and Knapp[9] in 1890. They simply expressed the lens, much as a seed would be expressed from a grape, by applying sufficient pressure with the thumb to the lower lid after the corneal section had been made. These authors admitted that "some" vitreous loss can be expected in this method!

There are many objections and disadvantages to most of these techniques which are fairly obvious. For example, most dislocated lenses cannot be made to fall completely into the anterior chamber for trapping by miotics, and when this is possible there is danger of the lens falling back when the anterior chamber is opened. Fishing blindly in the vitreous with a loop for an elusive and movable lens is an extremely hazardous procedure and should be avoided. Owing to the lack of support when the eye is opened the insertion of a loop even for the removal of a subluxated lens has its many drawbacks. Transfixion operations interfere with intracapsular extraction of the lens and would appear to be useful only for needlings. The introduction of a diathermy electrode into the vitreous carries the same hazard as the use of a loop. Irrigation of the vitreous is an uncertain method and should only be attempted in those cases with fluid vitreous.

Present technique

Barraquer's method of removing the dislocated lens involves the use of a double-pronged needle and we have tried various types of double-pronged needles in a series of 20 cases in an attempt to find the ideal needle for this operation.

In our first 10 cases we used a double needle improvised by securing two standard one inch 27-gauge hypodermic needles together at their bases, at first by a rubber band then later by solder (fig. 2-a and b). Although this made a fairly satisfactory instrument, the heavy weight of the handle as well as the lack of sharp cutting edge tips were definite disadvantages.

In four cases we used a specially constructed solid tapered-point double needle with a handle (fig. 2-c) but, like the hypodermic needle, there was difficulty both in inserting and withdrawing the needle.

In two cases we again improvised a double needle made by inserting two Keith abdominal triangular tip needles in a small cork (fig. 2-d). The ease with which the distance between the needle shafts could be varied was an advantage, but the large diameter of the needles proved to be a serious disadvantage. In both of the cases in which this needle was used we had serious complications: a vitreous hemorrhage in both and a retinal detachment in one. Therefore, we have abandoned this needle.

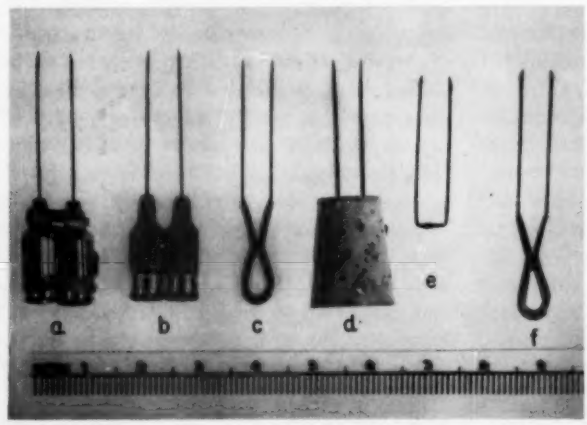


Fig. 2 (Calhoun and Hagler). The types of double-pronged needle utilized in our cases: (a) and (b) consists of two 27-gauge hypodermic needles; (c) our tapered-point needle with handle; (d) two Keith abdominal triangular tip needles inserted in a cork; (e) Barraquer's cutting edge needle; (f) our cutting edge needle with handle.

In four cases we used the needle described by Barraquer (fig. 2e). This needle has sharp cutting-edge tips as well as small diameter shafts, and penetrates the sclera with a minimum amount of pressure. However, we found it was very awkward to insert and withdraw this needle by means of a needle holder held at the necessary 45-degree angle.

From the experience gained by the use of these various needles we have developed a modified version of Barraquer's needle (figs. 2-f and 3). This needle is constructed of 27-gauge stainless steel and has a small light weight handle as well as extremely sharp cutting edge tips that face outward. The shafts are 25 mm. in length and are spaced 4.5 mm. apart. The handle definitely increases the maneuverability as well as the delicacy of "feel." Although we have used this instrument in only several recent cases, we feel its modifications have very definite advantages.

The same preoperative preparation is used for these patients as for our routine cataract extractions, except when it is anticipated that it will be necessary to turn the patient in the prone position during the procedure. In these patients a minimal amount of sedation should be given since their full co-operation will be helpful during the turning maneuvers. In all cases maximum dilatation of the pupil with Neosynephrine and homatropine is obtained. Van Lint orbicularis akinesia, lid and superior rectus sutures, a lateral canthotomy, a limbus-based conjunctival flap, and three McLean corneoscleral sutures of 6-0 chromic catgut are used routinely in all types of dislocations. Retrobulbar anesthesia is always used, except in children when general anesthesia is indicated.

Luxations into vitreous

The patient is placed in the usual supine position on a standard neurosurgical operating table with a projecting headrest. Careful attention must be paid to the draping of the patient's head as well as the headrest to permit turning the patient into the prone position without danger of contamination. The eye drape should be carefully secured so that it will not fall forward when the patient is rolled over. Recently, we have found it easier for the patient to roll into the prone position on the neurosurgical table from the original supine position on the operating room carrier, and to roll back later to the carrier for completion of the operation in a supine position (fig. 4).

Fig. 3 (Calhoun and Hagler). Our cutting-edge double needle, manufactured by Storz Instrument Company, St. Louis, Missouri.

After the limbus-based flap has been dissected three partially penetrating grooves are made in the limbus in the 10-, 12- and 2-o'clock meridians but no sutures are inserted at this stage. With our earlier needles it was advantageous to make two scratch incisions partially through the sclera in the horizontal meridian in order to make the scleral penetration easier. It was very helpful to stain these incisions with methylene blue in order to facilitate finding their location when the patient was in the prone position. With our latest needles the cutting edge tips are so sharp that it is not necessary to make any preliminary scleral incisions, but the sclera should be marked with methylene blue exactly five to six mm. from the limbus so that the needles will be introduced at the proper distance from the limbus and in a plane exactly parallel with the iris. A special marking instrument for this purpose is being designed.

At this stage the patient is turned over into the prone position with his chin and face resting in the projecting headrest allowing the patient's eyes to face directly downward over the end of the headrest in an unobstructed position. The neurosurgical table can be raised quite high to permit the operator to sit comfortably on a low stool during this part of the procedure, and it is

Fig. 4 (Calhoun and Hagler). Showing the first part of the operation being performed in the supine position. The patient will then be rolled to his left so as to rest his chin in the sterile-draped projecting headrest of the neurosurgical table in the foreground.

mainly for this reason that we have recommended using this type of table (fig. 5). Obviously, it is necessary to have available some type of good illumination that can be directed on the upside-down operative field. We have encountered no difficulty with the lid speculum and prefer to leave it in place during this stage of the operation.

Good scleral fixation should be obtained prior to inserting the needle. It may be necessary to move the eye slightly with the fixation forceps in order to get the lens to settle in its relatively normal position behind the iris and become centered in the pupillary opening but this usually occurs without any difficulty. While maintaining good fixation, the double-pronged needle is inserted five to six mm. from the limbus through the previously marked sites with the points at first directed posteriorly to be sure of getting behind the lens and then in a plane parallel to the iris. The points ideally should exit in the opposite sclera at the same distance from the limbus as the points of entrance. However, in cases in which the lens is small it may be necessary to bring the points out closer to the limbus to provide sufficient support for the lens.

On two occasions we found it necessary to insert a third needle perpendicular to the others to prevent the lens from slipping through the needles when the patient was returned to the supine position. The needle should be inserted deep enough through the opposite sclera so that the points are clearly visible and firmly fixed. If this is not done there is a definite possibility that they might slip out at a later stage during the procedure.

After the lens is securely supported by the needles the patient is returned to the supine position. Three McLean type sutures of 6-0 chromic catgut are inserted and the eye is opened with either a keratome or scratch incision, which is enlarged with scissors. Since there is always a possibility of losing vitreous, or of developing postoperative pupillary block, we advocate a complete iridectomy in all cases. Since the lens has no zonular attachments it is quite easy to lift it out with either capsule forceps or with an erisophake. The needles provide such good scleral support that we have not found

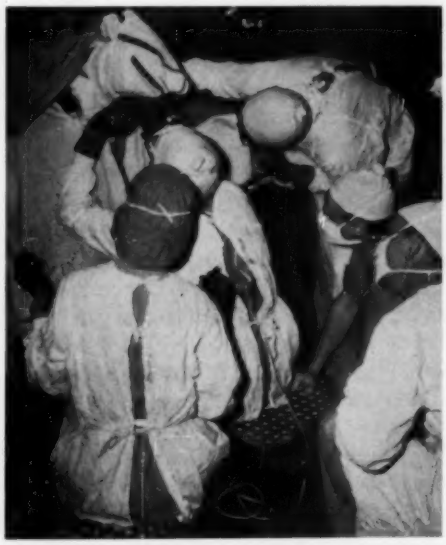


Fig. 5 (Calhoun and Hagler). With the patient in the prone position and his eye facing straight downward, the table is jacked up to its full height. The surgeon can be seen seated directly under the patient's head and is trapping the lens with a double needle.

it necessary to use the Fleiringer rings. After tying the preplaced sutures a large air bubble is inserted into the anterior chamber. The needle is then removed, the conjunctiva closed with a continuous suture of 6-0 chromic catgut, miotics instilled, and a monocular dressing applied. A special word of caution is indicated regarding the removal of the needles. If adequate scleral fixation is not obtained opposite the exit sites as well as opposite the entrance sites there will be a strong tendency for the globe to collapse with resultant vitreous loss. By trial we have found the most suitable method is to fixate the sclera near the exit sites with sharp scleral fixation forceps and to hold a lens loop around the entrance sites for counter pressure (fig. 6, 7, and 8).

Luxations into anterior chamber

We have not yet had the opportunity to use this technique in a case of luxation into the anterior chamber. However, we feel that the double-pronged needle should be utilized in these cases as a prophylactic measure to prevent the lens from falling back into the vitreous, an eventuality that is especially likely if retrobulbar anesthesia is used. Of course it would not be necessary to place the patient in the prone position, and the needle could simply be inserted in the horizontal meridian five to six mm. from the limbus.

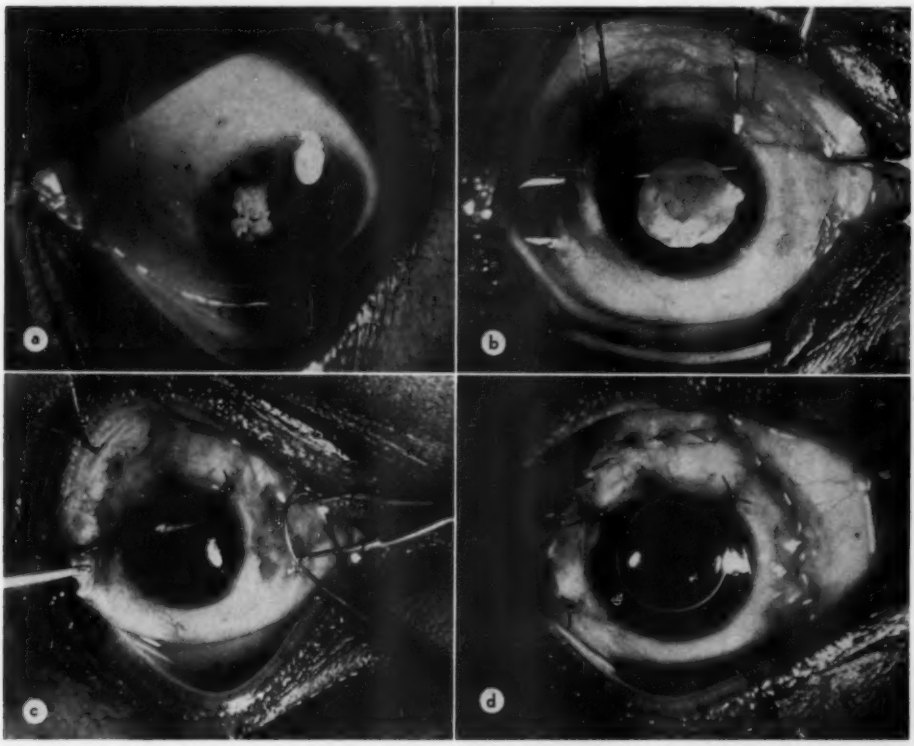


Fig. 6 (Calhoun and Hagler). M. W. H., a 38-year-old woman with phthisis bulbi, O.D., and a mature cataract in lower vitreous, O.S. Recent retinal detachment also present, O.S. (a) Prior to operation. (b) Lens (6.5 mm. in diameter) has been trapped in pupillary area by using our needle with patient in prone position. (c) After the cataract is removed and the sutures tied, the sclera is fixed at needle exit sites and slight counter pressure is applied around the exit sites with a lens loop prior to withdrawal of the needle. (d) At completion of the operation, showing air bubble in anterior chamber.

Subluxations

Since it should not be necessary to turn the patient into the prone position to remove a subluxated lens, there is no reason to use any table other than the standard operating table or carrier. The needles are inserted five to six mm. behind the limbus but the quadrant in which they are inserted varies with direction of the subluxation. In general, the needle should be inserted in the meridian in which zonular attachment remains so that its points can be passed behind the lens and the lens can simply be lifted forward by the needle. With our new needle it is not necessary to make preliminary scleral incisions and the needle can be inserted directly through the conjunctiva. As mentioned earlier we use a limbus-based flap, three preplaced corneoscleral sutures, and a complete iridectomy in all cases. Since the zonules are partially disrupted, there should be no difficulty with the actual delivery of the lens, either by the erisophake or capsule forceps.

Subluxations in children

In young children, even though the zonules are partially disrupted, we feel it would be safer to perform a discission rather than an intracapsular extraction. The extreme resistance of the remaining zonular fibers as well as the firm attachment of the posterior lens capsule to the anterior hyaloid[39] are reasons for this view. However, the double-pronged needle is still quite useful as a support to prevent the lens from being pushed back into the vitreous during the discission. The needle can be inserted behind the lens as we have described above for adults, or it may be actually inserted through the lens as in the manner described by Barraquer.

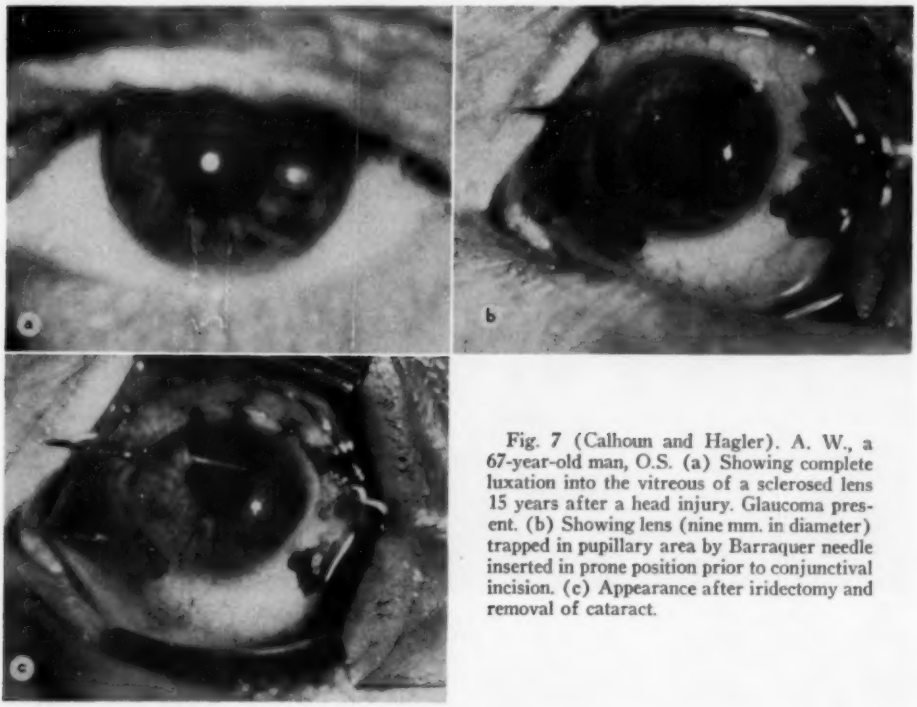


Fig. 7 (Calhoun and Hagler). A. W., a 67-year-old man, O.S. (a) Showing complete luxation into the vitreous of a sclerosed lens 15 years after a head injury. Glaucoma present. (b) Showing lens (nine mm. in diameter) trapped in pupillary area by Barraquer needle inserted in prone position prior to conjunctival incision. (c) Appearance after iridectomy and removal of cataract.

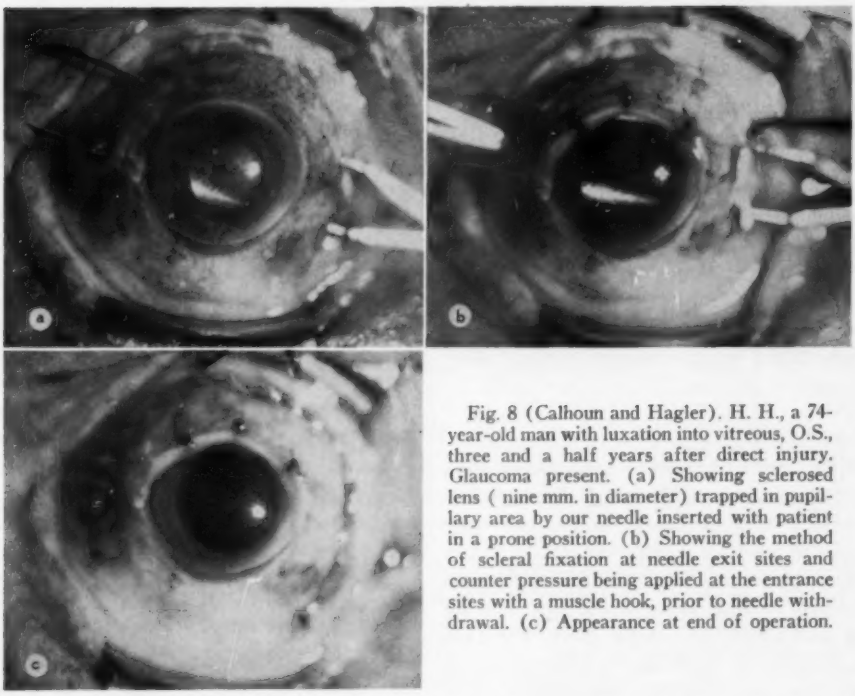


Fig. 8 (Calhoun and Hagler). H. H., a 74-year-old man with luxation into vitreous, O.S., three and a half years after direct injury. Glaucoma present. (a) Showing sclerosed lens (nine mm. in diameter) trapped in pupillary area by our needle inserted with patient in a prone position. (b) Showing the method of scleral fixation at needle exit sites and counter pressure being applied at the entrance sites with a muscle hook, prior to needle withdrawal. (c) Appearance at end of operation.

Analysis of cases

During the past nine months we have used this method of removing a dislocated lens in 20 eyes in the same number of patients. Of this group nine had lenses that were luxated into the vitreous and 11 had lenses that were subluxated. Sixteen of the dislocations were traumatic in origin, two were apparently spontaneous, and two were congenital. The duration of the dislocation in these traumatic cases varied from 11 days to 30 years with an average duration of seven years. The length of follow-up varied from six weeks to nine months.

The age of the patients varied from 11 to 79 years, with an average age of 55 years. There was a heavy predominance of involvement of the left eye. All of the luxated lenses were in the left eye as were seven of the 11 subluxations.

Five of the patients with luxations into the vitreous and six of those with subluxations, a total of 11, had glaucoma preoperatively. All except the 11-year-old girl with aniridia had normal widely open filtration angles. Tonographic studies were done on most of the patients with glaucoma and all had coefficients of aqueous outflow that were low or borderline. There were no patients who showed evidence of having glaucoma due to either pupillary block or hypersecretion of aqueous. In no instance could the luxated lens be made to fall through the dilated pupil by placing the patient in the prone position. There was no evidence of anterior uveitis, either past or present, in any of our cases.

Postoperative results

Postoperative course

In all cases the healing of the operative wound appeared to be just as smooth and

rapid as in the routine uncomplicated cataract extraction. The anterior chamber was always formed on the first day and in no case did late loss of the anterior chamber occur. A slight degree of striate keratopathy was present in several cases but this cleared rapidly in all instances. Most cases had mild transient haziness of the vitreous which cleared just as rapidly as in the usual uncomplicated cataract extraction. In most cases the extreme fundus periphery was examined with an indirect ophthalmoscope, and no abnormalities were noted in any of these patients.

Vision

In the cases of luxation into the vitreous the final vision was the same after surgery as before surgery except in the case that developed a retinal detachment. In the group of 11 subluxations the correctible vision was improved in four cases, made worse in no case, and unchanged in six cases. The failure to improve vision in the latter group of cases was due to pre-existing optic atrophy or other fundus pathology.

Complications

The lens was removed within its capsule in all cases except in the 11-year old child in whom the extreme resistance of the zonular fibers made this impossible.

At operation a loss of formed vitreous occurred in only three cases and was minimal in amount. This lessened tendency for vitreous loss due to the excellent scleral support provided by the double needle and the trapping of the lens anterior to the vitreous constitutes one of the chief advantages of this operation. This technique therefore has an unquestioned advantage over a loop extraction of a dislocated lens in a collapsed eye.

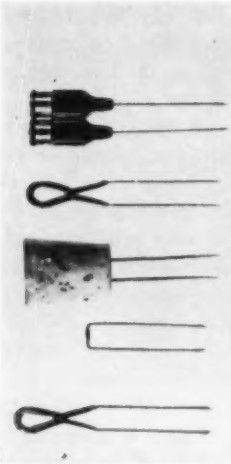
Retinal detachments occurred postoperatively in two cases. However, in one case the detachment was extremely small and localized around a tear that was not in a meridian in which needle punctures had been made. It is felt that this detachment, which was easily cured by surface diathermy, was not directly related to the use of the needle. In the other case the detachment was complete and occurred on the 17th postoperative day and was preceded by a heavy vitreous hemorrhage. The extraction in this case had been difficult and somewhat traumatic due to the extremely small size of the lens which required excessive maneuvering of the double needle as well as the insertion of a single needle at right angles to it. Furthermore, the exit sites of the needle in this case were through the corona ciliaris. In only one other case did a vitreous hemorrhage occur postoperatively and this cleared spontaneously. In both of these patients the Keith abdominal needles were used, and we therefore cannot recommend this needle. Figure 9 summarizes the major complications in relation to the type of needle utilized.

Effect of lens removal on intraocular pressure

The results of the lens removal on the intraocular pressure are summarized in Figure 10. Preoperative uncontrolled glaucoma was present in 11 cases. After lens removal, the intraocular pressure was controlled in five cases, unchanged in one case, and there has been insufficient length of follow-up in five cases. The chart will show that in one case of a subluxated lens glaucoma was produced by the operation. This event occurred in our first case due to pupillary block which resulted from failure to perform a complete iridectomy. This was not done because preoperatively no formed vitreous could be seen. However, peripheral formed vitreous was present, and this subsequently came forward and blocked the pupil, an event that has recently been emphasized by Irvine.[40] In all other cases a complete iridectomy was performed.

Indications for removal of dislocated lens

The problem of deciding when to remove a dislocated lens is certainly not an easy one



TYPE OF NEEDLE	SUBLUXATIONS	LUXATIONS INTO VITREOUS	TOTAL
HYPODERMIC 27 GAUGE	6 (ONE RET. DET.)	4	10
AUTHORS' TAPERPOINT	1	2	3
KEITH, ABDOMINAL TRIANGULAR POINT	1 (VIT. HEM.)	1 (VIT. HEM. AND RET. DET.)	2
BARRAQUER, CUTTING EDGE	3	1	4
AUTHORS' CUTTING EDGE	0	1	1

Fig. 9 (Calhoun and Hagler). Chart summarizing our 20 cases, showing type of needle used and complications.

to solve. Much has been written on this question throughout the years but there is still quite a bit of disagreement among various authors, especially in regard to the removal of a lens displaced into the vitreous. It appears that the extremely high rate of severe complications associated with the extraction of luxated lenses has tended to make most surgeons very hesitant to operate in these cases. We feel that the methods described in this paper are so much safer than previous methods that the operative indications should be revised and made less stringent.

In general, most authors do not feel that a lens luxated into the vitreous should be removed unless either uveitis or glaucoma develops. When these complications do develop practically all authors[14, 16, 32, 35, 41-43] state that the luxated lens should be removed, implying that removal will surely cure these complications. Chandler[18, 44, 45] disagrees with this view. He believes that the glaucoma usually results from a pupillary block and therefore he advocates iris transfixion or iridectomy as treatment for the glaucoma, not lens removal. He removes a lens from

SUBLUXATIONS 11 CASES		LUXATIONS INTO VITREOUS 9 CASES	
NORMAL I.O.P. BEFORE OP.	5	NORMAL I.O.P. BEFORE OP.	4
NORMAL I.O.P. AFTER OP.	4	NORMAL I.O.P. AFTER OP.	4
GLAUCOMA AFTER OP.	1		
GLAUCOMA BEFORE OP.	6	GLAUCOMA BEFORE OP.	5
CONTROLLED AFTER OP.	2	CONTROLLED AFTER OP.	3
UNCONTROLLED AFTER OP.	1	INSUFF. FOLLOWUP	2
INSUFF. FOLLOWUP	3		

Fig. 10 (Calhoun and Hagler). Chart summarizing the effect of lens removal on the intraocular pressure. Summary: Glaucoma was present preoperatively in 11 cases. After lens removal the glaucoma was controlled in five cases, unchanged in one case, and there was insufficient length of followup in five cases.

the vitreous only if it is hypermature and causing lens-induced uveitis. Barraquer,[1] on the other hand, removes all luxated lenses occurring in patients over six years of age, regardless of the clarity of the lens, or the presence of uveitis or glaucoma. All authors seem to agree that any lens luxated into the anterior chamber should be removed to prevent the development of pupillary block glaucoma.

Although many authorities, as we have stated, imply that removal of a luxated lens will cure the glaucoma if it is present, there have only been a few series of cases reported that tend to support this view.[25, 26] We are not aware of any large series of well-controlled cases that could be used to arrive at such a conclusion, nor are we aware of any animal experimentation along these lines. Certainly, our own series is too small and the length of follow-up too short to permit us to draw any definite conclusions as to the effect of removal of the dislocated lens on the glaucoma, although our results in those luxated into the vitreous are somewhat suggestive that removal may improve the glaucoma. We hope eventually to have a large enough series to draw some statistically valid conclusions along this line.

The severe complications resulting from a neglected mature or hypermature cataract, whether dislocated or not, are well known. The uveitis, glaucoma, disintegration of the luxated cataract and ultimate fixation of it to the retina inferiorly lead eventually to the loss of the eye. The natural sequence of events following the luxation of the clear or slightly cloudy lens into the vitreous is not so well known. According to Duke-Elder,[47] Irvine,[43] and Heath[46] the presence of any lens in the vitreous will eventually lead to the loss of the eye.

Until the sequence of events following the luxation of a clear or slightly cloudy lens into the vitreous does become better understood and documented we are recommending the following conservative indications for removal of a luxated lens.

First, we believe that any lens luxated into the anterior chamber should be removed regardless of the clarity of the lens, age of the patient, or state of the fellow eye.

Second, we believe that any cataractous lens luxated into the vitreous should be removed if it is mature or hypermature. However, the double-needle operation should not be used if the lens is very small or fragmented. In these cases it should be removed by trapping in the anterior chamber with miotics, if possible. Obviously, if the lens has become fixed inferiorly, the double-needle operation cannot be utilized.

Third, we feel that any lens regardless of its clarity should be removed if it seems to be the cause of a uveitis, or if the treatment of an associated retinal detachment is contemplated.

There does not appear to be so much disagreement among various surgeons on the indications for the removal of a subluxated lens. Heath,[46] Knapp,[17] McDonald,[25] Vail,[32] Barraquer,[1] and Irvine[43] all recommend removing any subluxated lens if either glaucoma or uveitis is present, or if necessary for visual reasons. Several have stated that any subluxated lens that shows evidence of progression should be removed before it becomes completely dislocated and falls into the vitreous.[1, 19, 25, 35]

We believe any subluxated lens should be removed if it is mature or hypermature, or if there is evidence of lens-induced uveitis, or if complete luxation into the vitreous seems imminent. We advocate removing relatively clear lenses that are subluxated if removal is necessary for optical reasons, such as high lenticular myopia, astigmatism, or troublesome monocular diplopia. The state of the fellow eye should influence this decision just as it does in any unilateral immature cataract. Figure 11 summarizes our present indications.

We would like to re-emphasize the fact that we have not included glaucoma as a sole indication for lens removal, nor have we recommended the removal of immature lux-

1. ALL LUXATIONS INTO THE ANTERIOR CHAMBER

2. THOSE LUXATIONS INTO THE VITREOUS IN WHICH:
   a. THE CATARACT IS MATURE OR HYPERMATURE, OR
   b. THERE IS EVIDENCE OF LENS-INDUCED UVEITIS, BUT ONLY WHEN
   c. THE CATARACT CAN BE MADE TO SETTLE INTO THE PUPILLARY AREA WITH PATIENT IN PRONE POSITION

3. THOSE SUBLUXATIONS IN WHICH:
   a. THERE IS A MATURE OR HYPERMATURE CATARACT, OR
   b. THERE IS EVIDENCE OF LENS-INDUCED UVEITIS, OR
   c. OPERATION IS NECESSARY FOR OPTICAL REASONS, OR
   d. COMPLETE LUXATION SEEMS IMMINENT

Fig. 11 (Calhoun and Hagler). Chart showing our indications for removing a dislocated lens. The postoperative results in the present series were too inconclusive to make the presence of glaucoma a definite indication for lens removal.

ated lenses if the eye is quiet. Neither the results in our series nor in other published series are conclusive enough to permit the inclusion of glaucoma as an indication for lens removal, especially since the exact role of the lens in the production of glaucoma is not known. By similar reasoning we do not recommend removing an immature luxated lens in a quiet eye, especially since the natural course of events in these cases is not well documented. However, since several authorities state that even clear lenses which are luxated will usually lead to the loss of the eye, we well may eventually urge prophylactic extractions in these cases, but only after sufficient clinical trial with lengthy follow-up has clearly demonstrated the safety of this method. As in any prophylactic surgery it must be unmistakably clear that the treatment is less dangerous than the disease.

Summary and Conclusions

We have reviewed the literature on the subject of the treatment of dislocated lenses and have outlined the principle surgical techniques previously described. We have investigated the feasibility and safety of a method of trapping and supporting the dislocated lens with a double-pronged needle passed through the pars plana, a method for subluxated lenses which was first described before the American Ophthalmological Society by Agnew in 1883, and more recently by José Barraquer in Bogota, Colombia, for all types of dislocated lenses.

We have reported our experiences in utilizing a double-pronged needle in the removal of the lens in 11 cases of subluxation and in nine cases of luxation into the vitreous. All but four of these cases were traumatic in origin. After experimenting with several types of needles, we conclude that a needle with a cutting edge tip is mandatory and have developed such a needle with a small light-weight handle.

Our technique for using the double-pronged needle is described in detail. In the series of 20 operated cases, postoperative complications occurred in six patients and were sometimes multiple. They consisted of slight, formed vitreous loss in three instances, vitreous hemorrhage in two, retinal detachment in two, and glaucoma in one. It is believed that these complications can be avoided in future cases by utilizing our im-

proved needle and fully developed technique.

Preoperative glaucoma was present in 11 cases. Following lens removal, the glaucoma was controlled in five cases, unchanged in one case, and in the remaining five there was insufficient length of follow-up. No information concerning the mechanism of the production of the glaucoma in these cases could be gained from the detailed preoperative study by tonography and gonioscopy. Since the real mechanism of the glaucoma in these cases is not understood and since the series reported in this paper is small and the length of follow-up short, we believe that removal of the subluxated lens or vitreous luxated lens cannot be relied upon to improve the glaucoma unless it is clearly due to lens-induced uveitis. Therefore, the presence of glaucoma is not a sole indication for lens removal in such cases.

We have briefly discussed and listed our indications for removing dislocated lenses in light of the technique described in this paper.

The advantages of the double-needle operation for the removal of dislocated lenses are:

1. The same technique and needle can be used for operations on the subluxated as well as the luxated lens in all age groups.

2. Vitreous loss is greatly reduced in frequency and amount because the needle furnishes excellent scleral support, and the lens is supported in an accessible position in front of the vitreous.

3. It permits an intracapsular extraction in all cases as opposed to operations in which the lens is deliberately transfixed.

4. The incidence of serious postoperative complications is less than with other methods.

We believe that the double-needle technique is such a practical, effective and relatively safe method for removing dislocated lenses that it allows a revision of the indications for their removal. The operation is a preferred substitute for any planned loop extraction.

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Ophthalmic Miniature

November 4th, 1667. From the Exchange I took a coach and went to Turlington, the great spectacle maker, for advice, who dissuades me from using old spectacles, but rather young ones, and do tell me that nothing can wrong my eyes more than for me to use reading glasses which do magnify much.

August 11th, 1668. At the office all the afternoon till night, being mighty pleased with a little trial I have made of the use of a tube-spectacall of paper, tried with my right eye.

The Diary of Samuel Pepys.
(During his 34th-35th year of age.)

RETINAL DETACHMENT FOLLOWING CONGENITAL CATARACT SURGERY:*

A STUDY OF 112 ENUCLEATED EYES

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In 1955 the causes of failure in congenital cataract surgery were analyzed[1] in a study of 56 enucleated eyes obtained principally from the Armed Forces Institute of Pathology. Retinal detachment had occurred in 41 percent of these eyes, the late cases developing on an average of 22.2 years after surgery. There appeared to be a connection between the type of surgery performed and the incidence of detachment, the evidence suggesting that the more the vitreous was disturbed the greater the likelihood of a detachment. In an effort to confirm these observations, 56 additional eyes removed after failure of congenital cataract surgery were obtained for study. The results of the examination of both series (a total of 112 eyes) are summarized in the ensuing report.

Retinal detachment following cataract surgery has been widely reported in the literature. Since many years (20 or more) may elapse before the detachment occurs, and the surgeon who extracted the cataract may no longer be seeing the patient, the association is not always recognized. According to Doggart,[2] however, enough evidence has now accumulated to warrant the assertion that an eye deprived of its lens has at least one chance in four of sustaining retinal detachment in the succeeding two or three decades.

Surgery for congenital cataract seems to be even more conducive to detachment than surgery for senile cataract. It was found by Shapland[3] after 10.7 percent of congenital cataract needlings and after only 2.3 percent of senile extractions. Foster Moore[4] also found that detachment occurred more often after removal of the lens in children, whether by extraction or discission, and went so far as to suggest that one eye only be operated in childhood, its fellow being held in reserve, unless the cataract in the fellow eye were so dense as to make that eye of little value if operated later in life. In a survey of 400 cases of retinal detachment, Knapp[5] found that 16 percent were in patients that had sustained congenital cataract surgery, and that atypical cataracts and cataracts with signs of degeneration were particularly subject to this complication.

A detachment can follow congenital cataract surgery at any time and for a variety of reasons, but the late detachments, occurring 10 or more years after surgery, are of special interest. Chandler,[6] Doggart,[2] and Shapland[3] have discussed them at length. Among 651 detachment cases, Shapland[3] found 22 in patients from whom congenital cataracts had been removed; 40 of the eyes had been needled, and in 33 of the 40, or 82.5 percent, detachment occurred from six to 41 years, or an average of 24.6 years, after surgery. Verrey[7] sites a case in which a detachment developed 45 years after the last discission.

As already noted, attempts have been made to relate the type of surgical procedure used in these cases to the postoperative complications, and particularly to postoperative detachment of the retina. On the negative side, Owens and Hughes,[8] in a relatively brief postoperative observation period of 16 months, found no connection whatever. A

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positive correlation between type of surgery and late detachment, on the other hand, has been recorded by a number of observers. Otto Barkan[9] associated retinal detachment in adult life with repeated discissions in early childhood, and Shapland,[8] Neame,[10] Cordes,[11] and Foster Moore[4] have all agreed that the danger of late detachment is greater after multiple needlings. Neame[10] has advised in particular against the Ziegler through-and-through operation as predisposing to this difficulty more than other procedures; and Chandler[6] also has objected to this operation on the ground that it disturbs the vitreous more than other procedures and is thus more conducive to late detachment.

Most surgeons agree with Velhagen[12] that intracapsular extraction is to be avoided since it may severely damage the ciliary body; after appearing to do well for a time, the eye may develop detachment and phthisis bulbi. As has been shown by Cordes[13] and others, the frequent presence of adhesions between the lens capsule and the vitreous face is another reason for avoiding intracapsular extraction, and is the reason the use of chymotrypsin must be regarded as of possible danger in congenital cataract surgery.

That disturbance of the vitreous is an important factor in the production of late detachment has been emphasized by a number of authorities. Chandler[6] found the danger heightened by disturbance of the vitreous at operation, especially if it were allowed to come forward into the anterior chamber, and for the same reason Velhagen[12] stressed the importance of avoiding injury to the posterior capsule, and through it to the vitreous. Maumenee[14] found that vitreous loss, which may occur in linear extraction, definitely increased the incidence of retinal detachment. Huerkamp[15] concluded that vitreous loss with displacement of the pupil was a definite factor in the production of detachment; he found the pupil displaced in 54 percent of a large series of cases occurring after cataract surgery. Cridland[16] summed up the matter by calling any procedure that disturbed the vitreous a bad procedure.

Pathogenesis

The various factors participating in the etiology of retinal detachment after congenital cataract surgery were studied by Shapland.[8] He concluded that progressive myopia was one factor that should be considered, particularly in eyes in which there was progressive stretching of the eyeball that would have included a high degree of myopia had the eyes retained their lenses. This study, the only one found in which refraction was considered, would indicate that in some cases of postoperative detachment the mechanism is essentially that of detachment of the retina in high myopia in eyes with lenses. In some of his cases Shapland was able to show progressive myopia in the aphakic eye. In these cases trauma was regarded as a very minor factor in the production of the detachment.

In nonmyopic eyes Shapland[8] suggested traction bands as one of the causes of detachment. He felt that in a certain percentage of cases the repeated needlings, especially when applied to a dense capsule, produced traction on the zonule and caused a retinal dialysis. It was his opinion "that the retinal margin flapped inward toward the vitreous, thus hindering reattachment, and that then years later, as the vitreous slowly underwent degenerative changes, the more fluid portion got behind the flap and initiated a retinal detachment in the usual way."

The same results can be produced by occlusion of the pupil or by a cyclitic membrane from which strands of connective tissue extend to the ciilary body and anterior retina. As stated by Velhagen,[12] in evaluating a membrane of this kind, it is difficult to differentiate between proliferation of the capsule and the formation of an inflammatory pupillary membrane. Any attempt to do further needlings in such a case would cause traction on the zonule and produce a retinal detachment. Denig,[17] Chandler,[6] Cordes,[18]

and others have all stressed the point that failure to do full iridectomy in cases in which the pupil cannot readily be dilated preoperatively may be a factor in the production of a pupillary membrane. If a cyclitic membrane forms, moreover, strands going directly to the ciliary body and peripheral retina may contract over the years and pull the retina loose spontaneously.

Another factor that should receive consideration is the organization of vitreous bands from vitreous in the anterior chamber, or from vitreous incorporated in a pupillary membrane. Cordes[1] was able to demonstrate the presence of such strands of fibrous tissue extending from the corneal wound of a discission through the pupillary area to the retina, where by contraction it had caused a detachment. In a linear extraction with vitreous loss the same condition could develop. Maumenee[14] found that any condition which caused vitreous retraction and traction bands increased the incidence of detachment.

Denig[17] added another possible cause in these cases by pointing out that delayed resorption of lens material could lead to relapsing irritation of the uvea and might thus precipitate detachment. Velhagen[12] agreed with this and advised that injury to the posterior capsule and vitreous should be avoided, especially so long as there was cortical material in the area of the discission, since such injury could delay resorption and induce the formation of an inflammatory pupillary membrane.

Denig[17] also commented on the cases in which retinal detachment has been associated with an epithelial dystrophy of the cornea. In his opinion the epithelial damage itself is rarely associated etiologically with the detachment but can be regarded as a sign of severe involvement of the uvea and its surroundings and thus as a warning and forerunner of detachment. Velhagen[12] commented on the corneal dystrophy that may result from contact between the vitreous and the posterior surface of the cornea. This again would appear to be a corneal change associated with the detachment rather than one of its causes.

Trauma as a factor in the production of retinal detachment in these congenital cataract cases is apparently of minor importance. However, Shapland,[3] Velhagen,[12] and Verrey[7] all stress the desirability of avoiding surgical trauma as much as possible, especially to prevent hemorrhage into the anterior chamber which may induce membrane formation when cortex is present.

Recurrent spontaneous hemorrhage in cases of late detachment has received scant attention in the literature. In the previously published series of 12 cases of late detachment,[1] there were four, all following multiple needlings, in which the detachment had occurred between 11 and 31 years after surgery and in which spontaneous intraocular hemorrhage was the immediate reason for enucleation.

Of passing interest is the fact that in these cases very few retinal holes are seen. This may be due in part to the fact that capsular remnants usually obscure the periphery of the fundus. Shapland[3] found only three definite holes and two possible retinal dialyses in 33 eyes in which detachment occurred after congenital cataract surgery. It was interesting that the three holes were all in myopes. The fact that holes are so seldom found may be one reason for the very poor surgical prognosis when reattachment is attempted (Chandler[6]). Shapland[3] reported 15 such attempts without a single success. In the course of his vast experience with retinal detachment surgery, Pischel[19] has found the surgical prognosis in these cases to be very poor but has had enough success to feel that a surgical attempt should always be made.

The surgery of after-cataracts following congenital cataract surgery also warrants a few words. According to Velhagen,[12] the formation of after-cataracts is more likely to occur in children than in adults by virtue of the frequency with which inflammatory pupillary membranes form. An attempt to do a

discission through such a membrane would result in an undue pull on the ciliary body which might lead to late detachment. Cridland[16] emphasized that in performing capsulotomy, the minimal procedure that would effect a central opening should be adopted. Velhagen[12] recommended that these membranes be cut with deWecker's scissors, to which Cordes[1] agreed and added that the procedure chosen should be one that would do the least possible damage to the vitreous so as to avoid, if possible, the complication of late detachment.

Report of study of 112 enucleated eyes

This report is based on the study of 112 eyes enucleated after failure of surgery for congenital cataract.

Surgical procedure. In the previous report,[1] evidence was accumulated that the type of surgery had some bearing on the development of retinal detachment, and particularly of late detachment. In the expanded series of 112 eyes analyzed herewith, 22 eyes (20 percent) had had a single needling; 46 (41 percent) had had multiple needlings; in two (two percent) a Ziegler through-and-through operation had been done; and 35 (31 percent) had been subjected to some form of linear extraction. In seven cases (six percent) it was impossible to determine the type of surgery that had been employed. It is interesting that in the first series of 56 eyes, 23 percent had had some form of extracapsular extraction, needling followed by extraction, combined extraction, or simple linear extraction as advocated by Otto Barkan. In the 56 eyes examined since that report, the percentage of linear extractions rose to 36 percent. Apparently the trend is away from multiple needlings.

TABLE 1

Detachment of the retina in 54 of the 112 eyes

(48.6 percent of all cases)

Type of Surgery		Number of Cases	Percentage
Discission	Single	7	12.98
	Multiple	27	50.00
Linear extraction		17	31.48
Ziegler (through-and-through)		1	1.48
Unknown		2	3.96

TABLE 2

Detachment occurring during first year

19 cases (37%)

Etiology	
Hemorrhage	8
Detachment diagnosed as tumor	3
Detachment associated with cyclitic membrane	5
Unexplained serous detachment	1
Detachment associated with sympathetic ophthalmia	1
Following "immediate postoperative complication"	1

Incidence of retinal detachment. As revealed by microscopic examination, detachment occurred in 54 (48 percent) of the 112 eyes (table 1). In seven of the 54 (13 percent) it followed a single needling; in 27 (50 percent) there was a history of multiple needlings; in 17 (31 percent) some form of linear extraction has been done; one patient (two percent) had had a Ziegler through-and-through operation; and in two patients (four percent) the type of surgery was unknown. It was striking to find that 50 percent of all the detachments, both early and late, occurred in patients who had sustained multiple needlings.

Interval between surgery and detachment

In this series the interval between surgery and detachment varied widely from less than one year to 33 years.

Detachment during the first year after surgery (table 2). There were 19 eyes in which detachment occurred during the first postsurgical year; 11 had had linear extractions and eight had been subjected to some form of needling procedure. In this group hemorrhage was an important factor, occurring in a total of eight cases. There were three instances of expulsive hemorrhage on the table (Cases 53, 67, 77), one instance of

Fig. 1 (Cordes). Expulsive hemorrhage at surgery. Linear extraction at six years of age.

spontaneous intraocular hemorrhage three days after surgery (Case 109), and another instance of spontaneous intraocular hemorrhage at the end of the first week (Case 9). Spontaneous vitreous hemorrhage occurred some time during the first year in Cases 84 and 104 (exact data not available), and in another instance resulted from trauma five months after surgery (Case 48).

In three instances (Cases 3, 70, 93), a detachment was misdiagnosed as a tumor and the eye enucleated within the first year. In Case 3 a white mass was seen behind the pupil soon after needling and was diagnosed "tumor"; in Case 70 the detachment was associated with a persistence of hyperplastic primary vitreous; and in Case 93 there was a complete detachment associated with a fibrocaseous granuloma.

The formation of a cyclitic membrane appeared to be the most important factor in five instances (Cases 9, 24, 90, 101, 104). In Case 54 there was an unexplained serous detachment, and Case 36 was associated with what appeared to be sympathetic ophthalmia.

The history of Case 37 stated that there were "immediate postoperative complications that resulted in detachment of the retina." The eye was enucleated 37 years later because of acute glaucoma.

In this series, then, the single most important factor in the production of retinal detachment during the first year was hemorrhage. It is noteworthy that the majority of the cases developing detachment during this period followed linear extraction.

Spontaneous expulsive hemorrhage on the table has not been generally regarded as an operative risk in congenital cataract surgery, yet in this series it occurred in three cases (fig. 1). In Case 53, a six-year-old boy admitted for linear extraction of congenital cataract, there was a massive intraocular expulsive hemorrhage when the lens capsule was grasped. In Case 67 there was extensive expulsive hemorrhage following "capsulectomy." Microscopic examination showed a gaping wound with massive subchoroidal hemorrhage and detached choroid and retina. In Case 77, a four-months-old baby, the eye was enucleated a few days after surgery with a diagnosis of possible intraocular tumor. Examination revealed a blood-filled gaping corneal wound and blood-filled anterior and posterior chambers resulting from extensive subchoroidal hemorrhage.

Detachment between the first and 10th years (Table 3). In 14 cases the detachment occurred between one and 10 years (average, four years) after surgery. Seven of the 14 followed linear extraction; four followed multiple needlings; two followed single needlings; and one followed surgery of unknown

TABLE 3

DETACHMENT OCCURRING ONE TO 10 YEARS AFTER SURGERY

14 CASES (26%)

OCCURRED AVERAGE OF FOUR YEARS AFTER SURGERY

Type of Surgery	Number of Cases	Cause for Enucleation	Number of Cases
Linear extraction	7	Uveitis	6
Needling (multiple)	4	Recurrent hemorrhage after trauma	2
Needling (single)	2	Phthisis bulbi	6
Unknown	1		

type. The 14 eyes were enucleated for the following reasons: for phthisis bulbi, six eyes—four after linear extraction and two after multiple needlings; for chronic uveitis, six eyes—three after multiple needlings, two after linear extraction, and one after surgery of unknown type; recurrent hemorrhage following trauma, two eyes.

In this group, then, the type of surgery would appear to have had no bearing on the occurrence of the detachment. It is of interest that in nine of these 14 cases, there was a cyclitic membrane, associated in six instances with a small pupil.

Detachment after 10 years (table 4). In 21 instances, or approximately 40 percent of the 54 eyes with detachment, the post-surgical interval was between 10 and 33 years. In this group the detachment followed multiple needlings in 16 cases (76 percent), linear extraction in two (nine percent), a single needling in one (five percent), and an unknown type of surgery in two (nine percent). The average time between surgery and detachment was 20.1 years, which approximates Shapland's finding[3] of 24.6 years. That 76 percent of the detachments in this group followed multiple needlings suggests a definite correlation between the type of surgery and late detachment.

Special clinical features

Immediate reason for enucleation. The 54 eyes that showed retinal detachment were enucleated for a variety of reasons. In some instances several clinical diagnoses were made but in the entire group the diagnoses immediately responsible for enucleation were as follows: Extensive recurrent hemorrhage with accompanying acute glaucoma, 11 eyes; glaucoma associated with recurrent hemorrhage after trauma, four eyes; expulsive hemorrhage on the table, three eyes; expulsive hemorrhage three days after surgery, one eye; severe chronic uveitis (diagnosed in three instances as sympathetic ophthalmia), 12 eyes; tumor, three eyes; anaphylactic iridocyclitis, one eye; phthisis bulbi, nine eyes; and acute painful glaucoma due to a variety of causes, 10 eyes.

TABLE 4

DETACHMENT OCCURRING 10–33 YEARS AFTER SURGERY

21 CASES (40%)

AVERAGE OF 20.1 YEARS AFTER SURGERY

Type of Surgery	Number of Cases	Percentage
Multiple needlings	16	76.1
Single needling	1	5.5
Linear extraction	2	9.2
Unknown type	2	9.3

Fig. 2 (Cordes). Detachment of the retina enucleated on diagnosis of intraocular tumor.

Intraocular tumor. In the entire series of 112 cases, intraocular tumor was listed preoperatively as a diagnostic possibility in 11 instances. In five of these (Cases 3, 51, 70, 77, and 93), detachment of the retina was responsible for the misdiagnosis (fig. 2). In one case (Case 77) there had been an undiagnosed intraocular hemorrhage at the time of surgery that left a gaping wound. In another (Case 51) there was proliferation of the pigment of the ciliary body onto the anterior surface of the detached retina, simulating a pigmented tumor mass.

The conditions responsible for the clinical diagnosis of tumor in five other cases were

Fig. 3 (Cordes). Hole in retina.

also of interest. Two were typical examples of the persistent hyperplastic primary vitreous of Reese (Cases 59 and 79). In one of these (Case 79), in which the eye was examined microscopically before Reese described the entity, the microscopic diagnosis was "chronic inflammation with lens remnants." In Case 60 there were large peripheral anterior synechias where the iris was adherent to the posterior corneal surface over a wide area. In Case 69, a nine-year-old boy, there was absolute glaucoma and a limbal staphyloma, "the choroid presenting through the thinned sclera." The clinical diagnosis was "melanoma of the choroid." Glaucoma, with a scleral staphyloma anterior to the equator, prompted a similar diagnosis in Case 72.

In the entire series there was only one case of intraocular tumor. The patient (Case 25), who was 15 months of age at the time of enucleation, had been subjected to a needling operation for congenital cataract six months earlier. At the time of surgery the surgeon had noted that the cataract was "very opaque and semisolid, appearing like calcium." Six months later the same ophthalmologist recorded that the "whole anterior chamber seemed full of calcium-like material." The eye was enucleated at this time. Microscopic examination revealed a retinoblastoma with necrosis and calcium degeneration (stage III). Almost all the structures of the eye showed massive invasion by the tumor. As pointed out previously, this possibility must be borne in mind in those cases in which there is a history of the development of "congenital cataract" several months after birth, especially if it is monocular.

Holes in the retina. As already noted, retinal holes are seen only rarely in cases of detachment following congenital cataract surgery. In only one instance in this series (Case 78) was it possible to demonstrate a hole (fig. 3). As already suggested, this absence of holes may be one reason for the extraordinarily poor prognosis of surgery for detachment in these cases. In the present series surgery for the detachment had been attempted in only one of the 54 cases and this ended in phthisis bulbi.

Cyclitic membrane formation. This complication was noted in 20 of the 54 cases of retinal detachment in this series (fig. 4). Eleven of these eyes were enucleated by the fifth year because of chronic uveitis, fear of sympathetic ophthalmia, intraocular hemorrhage, buphthalmos, or phthisis bulbi. The remaining nine were cases of late detachment.

That cyclitic membrane may be a factor in

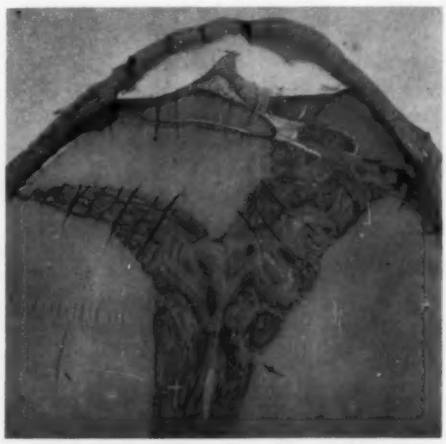

Fig. 4 (Cordes). Cyclitic membrane formation with detachment of retina.

causing retinal detachment was illustrated by Case 90 in which a detachment of a portion of the peripheral retinal was induced by strands from a cyclitic membrane. In Case 92, in which there was a dense cyclitic membrane attached to a completely detached retina, the membrane had pulled the ciliary body medially.

It seems clear that further needlings in a case with a dense cyclitic membrane, which may include lens fragments and capsule, could easily produce a retinal dialysis with the retinal margin turned inward toward the vitreous. This would prevent reattachment and permit degenerated vitreous eventually to get behind the retina and cause a delayed detachment. To avoid such trauma by a discission, the special deWecker's scissors or some comparable scissors should be used to cut the membrane.

Small pupil. Experience has shown that a small pupil resistant to preoperative dilatation is a factor in the development of complications after congenital cataract surgery. That it influences cyclitic membrane formation was strongly suggested by the fact that there was a small pupil in 13 of the 20 cases with cyclitic membrane in this series (fig. 5). This would seem to bear out the clinical observation that when the pupil cannot be dilated easily preoperatively, a full iridectomy is indicated.

Delayed resorption of lens material. This anomaly has been suggested as one cause of late detachment on the theory that prolonged irritation from lens material could ultimately have this effect. In the present series there were a number of cases in which considerable lens material remained, some of it degenerated. Microscopically, however, there was no evidence that this had caused attacks of uveitis, and thus no evidence that delayed resorption of lens material can produce late detachment.

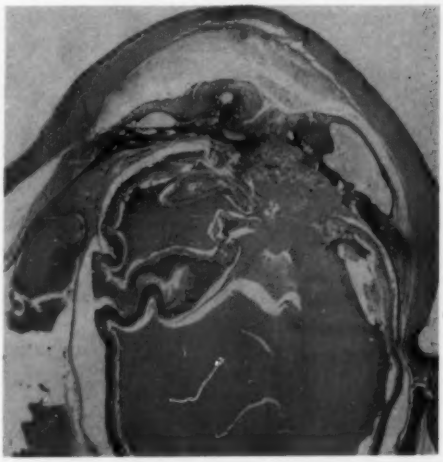

Fig. 5 (Cordes). Cyclitic membrane formation with presence of small pupil.

TABLE 5

LATE DETACHMENT OF THE RETINA

21 CASES

AVERAGE TIME BETWEEN SURGERY AND DETACHMENT 20.1 YEARS

Type of Surgery	Number	Percentage of 112 Cases
After multiple discission	16	14.2%
After single discission	1	.89%
After linear extraction	2	1.78%
After unknown surgery	2	1.78%
Total number of cases	21	

LATE DETACHMENT OF THE RETINA

Of particular interest were the 21 cases of detachment of the retina that developed 10 or more years after the last surgery for congenital cataract (table 5). As has already been stated, 16 (76 percent) of these followed multiple needlings, two followed linear extraction, one followed a single needling, and two followed unknown types of surgery. In many cases it was difficult to determine the exact time of the detachment because of inadequate records, especially if 20 years or more had elapsed, or if the original surgeon had been superseded. However, as well as could be determined from the histories and other data available, in this group the interval between the last surgery and the detachment varied from 10 to 33 years and averaged 20.1 years.

The microscopic findings in these cases have been analyzed in an effort to confirm or disprove the clinical theories that have been advanced to account for late detachment after congenital cataract surgery. In many cases there were apparently several contributing factors.

Traction on the retina. Of the 21 eyes with the late detachment, 10 (47 percent) had strands of connective tissue extending from the pupillary area to the detached retina.

In Case 14 there was a cyclitic membrane near the pupillary area which incorporated both the posterior surface of the iris and a portion of the completely detached retina. In Case 20, in which a detachment developed 18 years after multiple needlings, there was a well-developed cyclitic membrane incorporating both the posterior surface of the iris and a portion of the completely detached retina. In Case 43, after three needlings, some delicate strands of tissue extended across the pupillary space; they were connected with a membrane on the anterior surface of the iris, and with bands of tissue extending to the ora serrata above, below, and backward to the detached retina which was ruptured at the disc.

In Case 44 there had been five needlings; at a point where the incision had been made to needle the lens, there was a downgrowth of fibrous tissue which extended into the posterior portion of the globe; by contracting it had pulled on the retina and caused a detachment of both the retina and the choroid (fig. 6). In Case 90, which had sustained a single needling, strands from a cyclitic membrane extended to a peripheral detachment of the retina.

In Case 91, in which there had been multiple needlings, the eye was enucleated 33 years after the last needling; the pupil was occluded by a dense vascularized cyclitic membrane which extended from the pupillary area and was attached to lens remnants and to the detached retina. In Case 108, which had had multiple needlings, there were strands from a fibrovascular membrane occluding the pupil and extending to lens remnants and to the detached retina.

Three eyes were particular interesting. In Case 37, enucleated 20 years after multiple needlings which were followed by iridectomy for glaucoma, there were connective tissue strands extending from the corneal scar into the anterior chamber to become continuous with lens, iris, and detached retina. Case 55, which had sustained multiple needlings 20 years before enucleation, presented a similar picture. In Case 75, enucleated 10 years after the third discission, there was a dense membrane extending from the cornea to the partially detached retina. These three cases suggest the possibility that vitreous may extend through the pupillary area to the site of

Fig. 6 (Cordes). Retinal detachment showing traction bands going to retina.

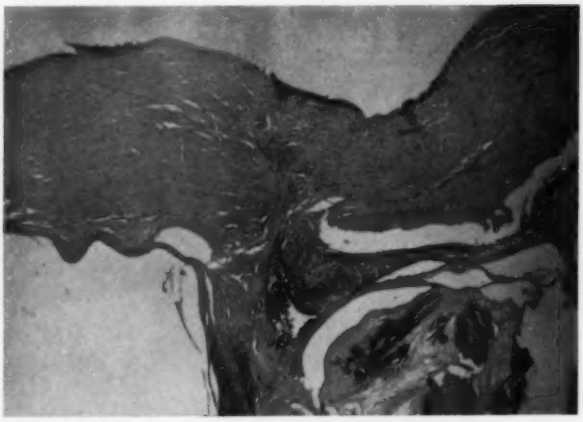

Fig. 7 (Cordes). Dense fibrovascular membrane adherent to operative scar, iris, lens remnants, ciliary body and retina. Followed vitreous loss in linear extraction.

the corneal wound made for the discission, and that organization of the vitreous may supervene. It is of interest that these three cases showed corneal edema, vascularization, and degenerated corneal changes.

It is clear, then, that late detachment can be a result of traction on the retina exerted by connective tissue bands. Since in this series all such cases had had multiple discissions, and in three cases strands extended to the corneal wound, it may be concluded that multiple discissions with resultant disturbance of vitreous can be a definite factor in the production of late detachment.

Vitreous loss at the time of operation. According to a number of authorities, vitreous loss, with vitreous incorporated in the wound, is likely to be followed by cicatrization, contraction, and eventual detachment of the retina. This was the sequence of events in Case 50 of this series in which there was a loss of vitreous at the time of surgery (a linear extraction) (fig. 7). The eye was enucleated 27 years later and showed a dense fibrovascular membrane adherent to the operative scar, the iris, lens remnants, ciliary body, and retina. While it could not be proved that there had been traction on the retina, the adherence of the membrane to the completely detached retina constituted good presumptive evidence.

Corneal changes (edema, bullous keratopathy, corneal dystrophy, vascularization). These changes are frequently found in association with retinal detachment—a result attributable in part to vitreous in the anterior chamber (fig. 8).

In the entire series of 112 cases, there were 59 eyes (53 percent) that showed one or more of these corneal changes. They were manifest in 31 (57 percent) of all 54 of the eyes with retinal detachment but in 15 (71 percent) of the 21 eyes with late detachment. As already noted, 41 percent of the entire series of 112 cases, and 50 percent of the 54 detachment cases, had had multiple discissions. However, among the cases of late detachment, in which there was a much higher incidence of corneal involvement, 89 percent had had multiple needlings. This would suggest that corneal edema, bullous keratopathy, epithelial dystrophy, and vascularization are more apt to occur after multiple discissions, possibly because of greater disturbance of the vitreous and a greater likelihood of there being vitreous in the anterior chamber. The corneal changes themselves, however, should probably be regarded as an additional complication of late detachment rather than being considered a contributing factor.

Spontaneous subretinal hemorrhage. This complication occurred in eight of the 21 late detachment cases in this series at intervals

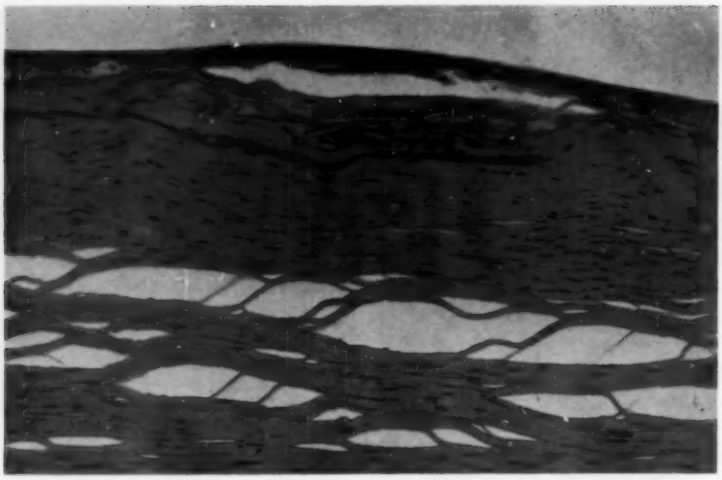

Fig. 8 (Cordes). Corneal changes, including calcification in old retinal detachment.

of between 10 and 25 years after surgery. No immediate cause for any of these hemorrhages could be determined, but multiple discissions had been performed in seven of the eight cases. The history of the eighth case was very meager 25 years after surgery, but all indications were that it had had a linear extraction. Late spontaneous hemorrhage after congenital cataract surgery is difficult to explain. The most generally accepted theories are that it is a result of degeneration of scar tissue, or of traction by scar tissue on the blood vessels.

Case 21 is of special interest. The patient had had a discission at five years of age, and another seven years later. Three years after the last discission, there was complete loss of vision within a period of three months. Six years later (that is, 16 years after the original surgery), the patient had a blind, painful eye that had a tension of 58 mm. Hg (Schiøtz). The pupil "was completely occluded with vitreous prolapse and subsequent adhesions of the vitreous to the iris" (fig. 9). Gonioscopy disclosed a completely blocked angle. Medical and surgical therapy were unsuccessful and the eye was enucleated. Microscopic examination revealed a degenerated detached retina and a massive suprachoroidal hemorrhage which detached the choroid. On one side vitreous strands were attached to the detached retina. The prolapsed vitreous observed clinically was attached to the anterior iris surface. This had produced the glaucoma. The degenerated detached retina with attached vitreous strands would indicate that the vitreous strands had caused the detachment and that the hemorrhage was a later incident.

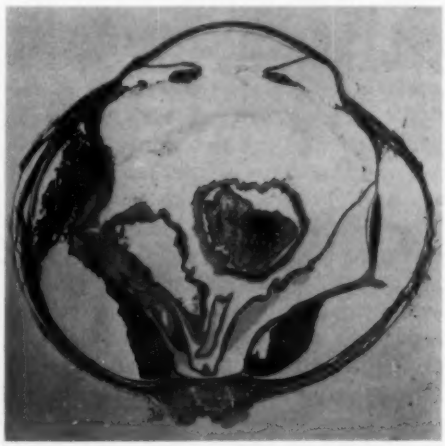

Fig. 9 (Cordes). Spontaneous intraocular hemorrhage 16 years after first surgery.

COMMENT

A series of 112 eyes enucleated after failure of congenital cataract surgery was studied to determine, if possible, the causative factors in the production of both early and late detachment of the retina. An attempt was also made to determine the relationship, if any, between the type of surgery and the incidence of detachment. Retinal detachment had occurred in 54 of the 112 eyes.

In an evaluation of these observations, it must be borne in mind that in many instances both the case history and the clinical data were meager and that attempts to obtain additional information were usually unsuccessful.

Type of surgery. In 50 percent of the 54 cases of retinal detachment, multiple needlings had been done; in 13 percent a single needling; in 31 percent linear extraction, and in one case a Ziegler through-and-through operation. In two cases the type of surgery was unknown.

For purposes of analysis the cases were divided into three groups according to the time interval between surgery and detachment, as follows: (1) detachments occurring in the first year (19 cases); (2) those occurring between the first and 10th years (14 cases); and (3) those occurring after 10 years (21 cases).

Of the 19 cases in which detachment occurred during the first year, three had expulsive hemorrhage on the table and a fourth had a similar hemorrhage three days after surgery. This has never been regarded as a surgical risk in congenital cataract surgery. All four hemorrhages followed linear extraction. That there should be four such cases in so small a series certainly incriminates expulsive hemorrhage as an operative risk when linear extraction is used in congenital cataract surgery. One wonders if the risk would be lessened, or perhaps removed, if the intraocular pressure were reduced as it is in senile cataract surgery, that is, by retrobulbar injection of procaine-hydrase and the application of digital pressure for five minutes before the operation is begun.

In three cases in this group, retinal detachment occurred within a year after a single needling. One followed "immediate postoperative complications," a second developed detachment accompanied by acute glaucoma, with persistent hyperplastic primary vitreous apparent in the third year. In the third case a diagnosis of tumor had been made prior to surgery.

In the patients in whom detachment developed between the first and 10th years, chronic uveitis, cyclitic membrane formation, and trauma with recurrent hemorrhage were the principal causative factors. In these cases there seemed to be no correlation between the type of surgery and the development of detachment.

Detachment of the retina occurring after 10 years included 40 percent of the detachment cases, the time varying between 10 and 33 years after the last surgery. In this group 76 percent had had multiple needlings. This confirmed the conclusion drawn from the previous study[1] that multiple needling is the least desirable of all procedures.

Intraocular tumor. It is of interest that in five instances a detachment of the retina, either preceding or following surgery, was misdiagnosed as intraocular tumor and the eye enucleated therefor. However, the fact that in another instance a retinoblastoma was found emphasizes the importance of keeping this possibility in mind.

Cyclitic membrane. The presence of a cyclitic membrane in association with a small pupil in a number of these cases emphasized the danger of complications when the pupil cannot be dilated easily preoperatively. As has been reiterated in the literature, it is in these cases that a full iridectomy is indicated.

On the other hand, a cyclitic membrane may extend to the periphery of the retina without a detachment. This should be recalled when the making of an opening through such a membrane is contemplated. It is apparent that forcing a discission needle through such a membrane may cause the

retina to detach as a result of the pull on the band going to the retina. In these cases some form of scissors opening should be made.

Traction on the retina. Detachment of the retina resulted from connective tissue band traction in 18 of the 54 cases with detachment. This connective tissue arose either from a cyclitic membrane or from what appeared to be organized vitreous extending through the pupil and attaching to the detached retina. In one instance these strands of connective tissue had detached a peripheral portion of the retina to which they extended. It is noteworthy that in all of these cases there was a history of multiple needlings. In one instance there was a membrane extending from the operative scar to the detached retina of an eye which had sustained vitreous loss during a linear extraction.

Corneal changes. In this study there was nothing to indicate the relationship between corneal changes and retinal detachment that has been mentioned in the literature. It appeared, however, that the presence of vitreous in the anterior chamber probably had a deleterious effect on the cornea.

Spontaneous intraocular hemorrhage. In eight of the 21 cases of late detachment, spontaneous intraocular hemorrhage occurred from 10 to 25 years after surgery. This was probably the result of degeneration of scar tissue, or of traction on blood vessels by scar tissue.

Conclusions

1. Linear extraction of congenital cataract, while appearing to be the safest procedure so far as retinal detachment is concerned, carries with it a small but definite risk of expulsive hemorrhage on the table.

2. Uveitis is commonly associated with detachment and often also with a cyclitic membrane and small pupil, indicating the importance of iridectomy when the pupil cannot be easily dilated preoperatively. This emphasizes the importance of the local use of corticosteroids postoperatively in order to minimize the inflammatory reaction and resultant connective tissue reaction.

3. Multiple needlings seem to carry the greatest risk of late detachment; they were associated with 76 percent of all cases of late detachment occurring on an average of 20 years after the last surgery.

4. Traction bands from a cyclitic membrane or organized vitreous, pulling on the retina, were present in almost 50 percent of the cases of late detachment. All these cases followed multiple needlings. It is clearly of great importance to avoid damage to the vitreous.

5. The presence of bands of connective tissue extending from dense cyclitic membranes to the retina, as seen in cases without detachment, emphasizes the importance of cutting these membranes with scissors rather than attempting a discission which would put the bands under traction between the membrane and the retina.

6. Spontaneous subretinal hemorrhage occurred in 38 percent of the cases of late detachment between 10 and 25 years after the last surgery. All these cases followed multiple needlings.

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ABSORBABLE GELATIN FILM (GELFILM) IN OPHTHALMIC SURGERY

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The search for a nonantigenic absorbable material for use in human tissues was first described by Correll and Vander Poel.[1] They experimented with gelatin films in vitro and in vivo. Resistance to water solubility was imparted to the film by hot-air heating of the dried film or by addition of minute quantities of formalin to the original solution. A combination of the two techniques gives a greater degree of insolubilizing.

Gelfilm, made from pig gelatin, is such a material. It is sterile, approximately 0.75 mm. in thickness. When dry it has a stiff consistency similar to plastic of the same thickness. When wet it conforms to almost any surface against which it is laid. It is soft and cannot be pushed when wet but is of such tensile strength that it may be grasped and pulled into any area. It is gradually absorbed from body tissues in from one to six months, depending on how vascular the tissue is.

Weisel, Ross and Lubitz[2] implanted Gelfilm into two groups of patients and found it to be nonpyogenic, nonantigenic, and completely absorbed from normal intermuscular fascial planes in eight to 14 days. There was only minimal foreign-body reaction, fibroblastic or cellular reaction in the implanted area.

Weinmann and Correll[3] implanted pieces of film 10 by 12 mm. between two muscles in the legs of rats. These were then killed at various times and, after staining, the tissue reaction was appraised. With insolubilized gelatin film they found an inflammatory reaction consisting of edematous fluid and neutrophilic leukocytes which lasted only one day. In control animals with no implant the connective tissue response was as extensive. After three days, the edema subsided and the film was covered by a syncytial mass of cells, indicating giant cell formation. Three weeks later the film was shredded and giant cells were in abundance. By five to six weeks the film was completely absorbed. They concluded that the film was digested by proteolytic enzymes elaborated by giant cells.

The first ocular use of Gelfilm was reported by Laval[4] as an adjunct in the iridencleisis operation previously described by him. The material was not inserted into the anterior chamber but was used to provide a subconjunctival drainage area by preventing adhesions of the conjunctiva to the episclera. No inflammation was found in experimental

rabbit eyes when Gelfilm was used in this manner. Subsequent use of the material in human eyes gave satisfactory results. Laval used it in this manner in 24 patients.

In my own practice I have performed this procedure for glaucoma, using Gelfilm, in 20 cases, 30 eyes in all, with no untoward result. One of these cases was in a 34-year-old white woman with unilateral glaucoma uncontrolled with miotics and Diamox. The results in this case made me so enthusiastic that I requested the manufacturers of this material to prepare a special ophthalmologic package of smaller size than the regular package. Only a very small amount, approximately 4.0 by 10 mm. is usually used (the regular package is 100 by 125 mm.). The material is difficult to resterilize, requiring a special baking oven.

Many investigators have reported the use of Gelfilm in extraocular muscle surgery and in diathermy operations for retinal detachments to limit the amount of adhesions formed postoperatively.

Laval[5] described the use of Gelfilm in detached retina. After the diathermy punctures were made, with or without scleral resection or vitreous implant, a piece of Gelfilm was placed against the sclera and the muscle sutured over it. Another piece was placed above the muscle and the conjunctiva closed above it. Adhesions of conjunctiva to muscle and muscle to sclera are thus prevented, if a second operation becomes necessary. It is used in cyclodiathermy procedures in the same way.

Laval also uses the material in ocular muscle surgery, placing it between sclera and muscle before the muscle is rejoined to the stump. Another strip is placed between muscle and conjunctiva before closure of the conjunctiva. Laval feels that better motility is obtained.

Barsky and Schimek[6] state that subconjunctival implants require two to three months to absorb. They used Gelfilm in a series of rabbit experiments and on the basis of these felt that it could not be recommended for cyclodialysis for the following reasons: (1) considerable trauma is involved in the complex technique of insertion; (2) intraocular reaction is prolonged and fibrosis is prominent (in rabbits); (3) gelatin film does not consistently hold the cleft open.

A subsequent publication by the same investigators[7] reported three cases in which Gelfilm was used in humans. They concluded that, although the material did not cause any violent inflammation, there was evidence of a prolonged low-grade inflammatory response. Part of this, they felt, might have been due to physical irritation of the material against a mobile iris and operative trauma—but undoubtably some was due to the irritation from the Gelfilm itself. It was felt that tissue reaction may vary between different samples of the material.

Lehman and McCaslin[8] reported results in a similar operation, excepting that the incision was made at the limbus under a flap. No reaction was found in rabbit eyes but in two patients a marked inflammatory reaction ensued, marked by flare and cells in the aqueous. The inflammation subsided upon removal of the setons. These writers felt that perhaps the rabbit eyes were normal while the human eyes were in a previously injured state.

Pilger[9] describes a modification of the Jameson[10] operation for the relief of epiphora after dacryocystectomy in which a subconjunctival separation of the lacrimal ducts is performed. The entire secretion of the major glands is diverted into the surrounding tissues. Jameson described the operation as follows:

> The subconjunctival separation of the fornix from its basic tissue should extend in breadth five or six millimeters, i.e., from the margin of the tarsal curve to the beginning of the bulbar conjunctiva, and in length this broad separation strip should measure some fifteen to eighteen millimeters. The primary incision should be beneath the external commissure, as one of the largest ductules is situated below, and the subconjunctival dissection at the commissure should come farther forward to the margin of the lid in this region.

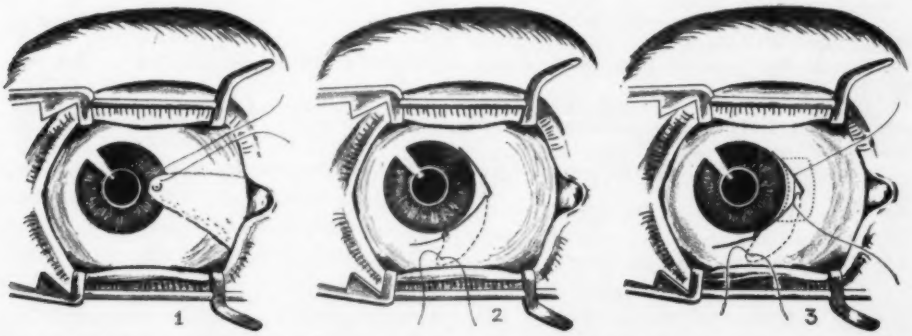
The Schirmer test was used as criterion of cure. Jameson felt that the operation could be graded and limited by the length of the dissection of the ductules. No length of time was given in the article for criteria of cure. Failure of the procedure is due to rapid reformation of the ducts.

The rate of success in this procedure has been greatly increased by Pilger's placing a strip of Gelfilm three mm. by six mm. parallel to the tarsus at the conclusion of the Jameson procedure. Pilger reports improvement in all cases of his series with complete relief from epiphora. The Schirmer test was used in addition to the patient's response. Insertion of the material is by a small bayonet type forceps or ordinary fine dressing forceps. In my own practice for the past several months I have used Gelfilm after transplant for pterygium in two groups of patients. In the first group a modified McReynold's transplant was performed. The extending "point" of the pterygium was dissected off and, after enlarging the incision by a peritomy above and below the area, the pterygium was turned on itself and transplanted below the limbus at the 6-o'clock position as far into the fornix as it would stretch. No other incision was made in the conjunctiva. This leaves a small area not covered by conjunctiva at the former site of the growth (figs. 1, 2, and 3).

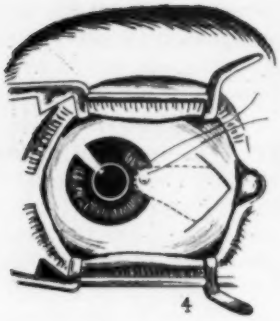
A piece of Gelfilm approximately three by six mm. was laid along the limbus under the area where the pterygium grew previously and the conjunctiva was closed over it with a single suture. No attempt was made to hold the Gelfilm in place, as it remains in contact without shifting. No edema or redness was noted and the Gelfilm could be seen quite well for approximately three weeks.

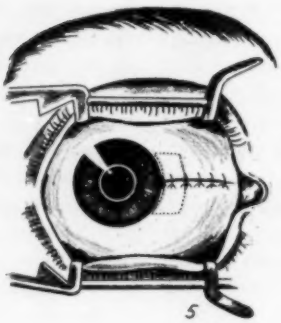
In a second group of cases the pterygium was removed completely, in a manner similar to that described by Sugar.[11] Whereas, Sugar recommends the excision of a subconjunctival layer of "tendinous" Tenon's fascia, in this series the whole pterygium was cut off completely, including conjunctiva, to approximately 12 mm. from the limbus. Sugar advanced the theory that a degenerative process leads to hyperplasia and hypertrophy of the elastic tissue and deposition of hyaline, which causes an elevation that eventually separates the epithelium from Bowman's membrane. Repetition causes the extension of the pterygium. It was therefore felt that if a space could be created the process, as described by Sugar, could be blocked (figs. 4 and 5). After removing the pterygium a strip of Gelfilm three by six mm. was placed at the limbus, as in the first group, and the conjunctiva was closed to the limbus with sutures.

Although it is too early and this group of cases is too small to state definitely, I am of the opinion that this procedure is more



Figs. 1, 2, and 3 (Zugsmith). Procedure used on first group of patients, showing modified McReynolds technique with Gelfilm in place.





Figs. 4 and 5 (Zugsmith). Procedure used in second group of patients, showing modified Sugar technique with Gelfilm in place.

effective for pterygium than the standard one. There have been no cases of recurrence in these two series and the reaction present with bare sclera is not seen. Reaction to the implanted material lasts about three weeks.

Summary and Comments

The material Gelfilm, is a relatively nonantigenic, nonpyrogenic, and absorbable substance for extraocular use. It is valuable in creating a subconjunctival space and preventing adhesions. The experience of several investigators suggests that intraocular use should be performed with caution. A description of two new applications of the material in ophthalmic surgery is presented: (1) in prevention of reformation of the ducts after the Jameson procedure and (2) the insertion of a small strip to prevent recurrence of pterygium when removed by two different techniques.

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REDUCTION OF INTRAOCULAR PRESSURE USING PLASTICS IN SURGERY*

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Most surgical textbooks state that fistulizing operations for glaucoma are approximately 85 percent successful.[1] A second, third, or even fourth surgical procedure will also lower the number of cases in which glaucoma still persists. However, today many patients continue to lose their vision from uncontrolled glaucoma despite all modern medical and surgical procedures. It is the purpose of this investigation to find a new surgical procedure to be used in those cases in which all conventional medical and surgical treatment have failed. An attempt has been made to guarantee the permanent drainage of aqueous by using a plastic, silicone rubber, in glaucoma filtration surgery in rabbits.

HISTORICAL REVIEW

In the past, many attempts have been made to implant foreign materials in the eye to reduce the intraocular pressure in filtration surgery. The following brief review of these seton operations is outlined in Table 1.

In 1906, Rollet and Moreau[2] performed a double paracentesis and used horsehair through the corneal punctures to treat hypopyon associated with corneal ulcer. They glued the horsehair ends to the cheek with collodion for 48 hours in the 18 cases they reported.

In 1907, Rollet[3] repeated this treatment satisfactorily in two patients with painful absolute glaucoma.

In 1912, Zorab[4] treated glaucoma by draining the anterior chamber to the subconjunctival space with a single silk thread left permanently in place. Zorab first passed a silk suture under the conjunctiva through the corneoscleral junction, then across the anterior chamber and through the opposite limbus to the subconjunctiva on the opposite side. Zorab[5] later favored a procedure he referred to as "aqueousplasty." In this operation he inserted a double silk loop through a superior keratome incision two mm. behind the limbus and then covered the silk with a conjunctival flap. Zorab used these methods in 23 cases and controlled the tension in 18. In one case the glaucoma persisted and in four the silk was not retained.

Maou,[6] in the same issue of *Ophthalmoscope* containing Zorab's first report in 1912, used essentially the same method in four glaucoma cases. He used a single silk thread five-mm. long to act as a wick under the conjunctiva. A year later Mayou[7] reported the results in 10 more cases. The pressure was controlled in 11 of the total 14 cases.

Wood,[8] in 1915, successfully treated five cases of absolute glaucoma using Zorab's "aqueousplasty." He also developed his modification in the surgical technique of this operation.

In the same year, Derrick T. Vail[9] reported a case on which he had operated in 1907. He drained the vitreous with a No. 10 black silk plaited thread in the treatment of a case of absolute glaucoma. He inserted a needle with the silk through the sclera, choroid, and retina, in the region of the ora serrata, and then into the vitreous and out through the same coats of the eye to the episclera. He buried each end of the suture under Tenon's capsule on the episclera, extending back to the equator. He removed the thread in three months and the patient had no return of glaucoma two years later at the time of his death.

In 1922 Weekers[10] successfully employed a hollow gold cuff, 2.0 by 1.5 mm., to drain the aqueous in several cases of absolute

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glaucoma. He placed the cuff under the conjunctiva and Tenon's capsule in a scleral trephine hole seven mm. back from the limbus. Weekers stated that the gold was well tolerated by the eye and was essential to prevent scleral wound closure.

Stefansson,[11] in 1925, inserted a T-shaped piece of gold through a keratome incision at the 12-o'clock position to drain the anterior chamber to the subconjunctiva. He used twisted gold wire, a hollowed gold tube, or solid gold, with the vertical part of the T in the anterior chamber and the two limbs on the sclera and covered by conjunctiva. He controlled the pressure in 80 percent of 32 eyes followed for an average of three years but some cases were only followed for a few weeks. Puncture of the conjunctiva by the gold, dislocation of the gold implant, and iris atrophy were the complications he reported.

In 1934, Row[12] placed platinum-iridium wire in a cyclodialysis cleft. Because of the trauma of the operation, a cataract developed. Then he used horsehair and controlled the tension in three cases of glaucoma in man. Row stressed that the ends of the horsehair be placed under Tenon's capsule in order to avoid later erosion through the conjunctiva.

Wolffe and Blaess[13] performed their modification of the Zorab operation in 1936. They successfully treated six cases, draining the anterior chamber to the subconjunctival space by using silk thread. If the tension later became elevated, they advocated subconjunctival manipulation of the suture.

Troncoso,[14] in 1940, reported on the use of a magnesium sheet implant in a cyclodialysis cleft. Oxidation caused the metal to disappear at the end of two weeks. However, this was accompanied by a moderate inflammatory reaction. Hydrogen gas bubbles were produced and a fibrous capsule formed around these bubbles in the suprachoroidea so that no continuous channel could be demonstrated in any eye. The patients also experienced considerable pain while the magnesium was being disintegrated. He reported good results in two eyes, apparently good results in four, and failures in four other human eyes.

In 1942[15] Dr. Glenn Gibson transplanted the lacrimal canaliculus in research using dogs. He placed the canaliculus through the sclera, two mm. from the limbus, into the anterior chamber. Microscopic study, however, failed to show that an entirely patent channel resulted and the fate of the two ends of the canaliculus was never determined. The transcleral lacrimal transplant was also performed on a patient blind with glaucoma. However, the external end of the canaliculus was closed by subconjunctival scar tissue and the lens developed a partial opacity.

Dr. Malcolm Bick[16] of the Wilmer Institute, in 1949, reported on the use of tantalum tube as an aid in lowering the intraocular pressure. He inserted the tube in cyclodialysis clefts to drain the anterior chamber through the suprachoroidea to the sclera in rabbits. While aqueous drainage occurred, local pannus formation and injection of the episcleral vessels resulted. He believed this to be due to the "mechanical irritation of the rigid foreign body" which was "chemically inert but too unyielding." Bick also inserted tantalum plates into cyclodialysis tunnels in four human glaucomatous eyes but the tensions remained normal for only two weeks.

Troncoso[17] changed to tantalum in 1949. He used a fine tantalum-foil tube in the cyclodialysis cleft which remained patent in the rabbit eye for eight months. He also used tantalum sutures, foil, and tubes in trephine holes connecting the anterior chamber to subconjunctival space, as well as in cyclodialysis clefts.

In 1951, Muldoon[18] and his coworkers reported on the use of platinum wire inserted between the anterior chamber and subconjunctiva at the limbus. This resulted in a functioning bleb in two human subjects.

In 1951, Haberberger[19] inserted a protoplast loop through an Elliot trephination

and the loop was well tolerated in a 58-year-old patient with glaucoma. In a discussion that followed this report, H. Fanta related the attempts of a colleague to use a silver loop in a similar manner. This was not successful since a frank fistula invariably developed, thus destroying the conjunctiva.

The following year, Losche[20] placed a hollow spatula of Supramid in a cyclodialysis cleft. This method was tested on pig eyes.

In 1954, Qadeer,[21] in Pakistan, used acrylic plates in glaucoma surgery in human eyes. In his report he mentioned the complications of slipping of the plate into the anterior chamber or in the opposite direction, that is, completely out of the anterior chamber. He reported good results in 14 eyes but in two cases a second plate had to be incorporated in order to lower the pressure. The follow-up period was only three months in six patients, six months in two patients, and in the remaining four patients the pressure was controlled at the date of the report.

Bietti,[22] in 1955, inserted a polyethylene tube into the suprachoroidal space, after cyclodialysis, to drain aqueous from the anterior chamber. He reported that these tubes were well tolerated in rabbit eyes. Bietti was able to normalize the pressure in five of eight human glaucomatous eyes. He suggested a second implant in another quadrant if the tension remained elevated.

Laval[23] used absorbable gelatin (Gelfilm) in glaucoma filtration surgery and reported promising results in 1955.

Strampelli[24] used Supramid thread in a cyclodialysis cleft to insure permanent filtration. In 1956 he reported encouraging results in four cases.

Teulieres[25] incised the conjunctiva and sclera six mm. from the limbus. He then placed a catgut suture through one side of the scleral wound in such a way as to keep the wound open. In this manner filtration could be guaranteed according to Teulieres' report in 1956. However, the follow-up time was not mentioned.

In 1958, William Stone, Jr.,[26] of the Massachusetts Eye and Ear Infirmary in Boston, reported the use of a thin-walled tantalum tube with a fenestrated plate at the end. The tube end extended into the anterior chamber, while the fenestrated extremity was sutured to the sclera under the conjunctiva. Two-thirds of the tube was placed intracorneally and the tube was rigidly fixed. Fibrous tissue grew into the fenestrations in the plate. A very small corneal opacity and several small vessels grew into the cornea at the site of the tube.

In 1958, Barsky and Schimek[27] reported using Gelfilm in cyclodialysis clefts in rabbits. They concluded that it could not be recommended because of (1) the trauma involved in the insertion; (2) the prolonged postoperative reaction and increase of chronic inflammation, scarring, and fibrosis, and (3) the gelatin film did not consistently hold the cleft open.

LaRocca reported treating a case of buphthalmos at the International Congress of Ophthalmology in 1958.[28] He used a polyvinyl U-shaped tube to drain the anterior chamber to subconjunctival space with encouraging results.

Lehman and McCaslin[29] used gelatin film as a seton in 1959. Because of the inflammatory response following this form of surgery, they recommend further research prior to the use of Gelfilm in the treatment of glaucoma.

Present study

The complications arising from the use of these various seton operations include erosion of the conjunctiva, keratitis, iris atrophy, iritis, dislocation of the implant, severe inflammatory reaction, scar formation, and blockage of filtration.

The two basic problems involved in this glaucoma filtration surgery are (1) the toxicity of the material introduced into the eye, and (2) the permanent positioning of this material so that it will not move.

Material employed

It is obvious that the material to be used

is especially important. It must be completely inert or it will cause an inflammatory response which, in turn, will induce even more scar tissue formation that will later block the filtration of aqueous. Many materials used in other fields of surgery were investigated and the plastic, silicone rubber, was thought to be most suitable for many reasons.

Silicones are polymeric materials and the basic structure of the chain is a succession of silicon and oxygen atoms—(Si-O-Si-O) rather than successive carbon atoms (C-C-C-C). One or more organic radicles is usually attached to each silicon atom. The silicone polymers may take the form of liquids, resins, or rubbers. The silicone rubbers have been useful because of their marked inertness physiologically and because of the following properties:

1. Silicones have low adhesive properties and keep adhering materials from sticking together.

2. Because of their nonwettable properties, they do not become encrusted. As drainage tubes they are superior to rubber because they clog much less readily than tubes of organic rubber.

3. Silicones delay the clotting of blood. By treating glass tubes and other surfaces with a silicone coating, anticoagulant may be omitted without the blood clotting.[30-33]

4. Silicones are not attacked by enzymes.

5. They do not support bacterial or fungus growth.[30]

6. Silicones are stable to heat and can be sterilized by autoclaving. Also, they are not altered by temperatures below 150°C. They can be washed in alcohol, ether, and detergents.

7. Silicones have never shown allergenic properties.

8. Silicone rubber is soft and flexible, much softer and more easy to work with than polyethylene or Teflon.

9. Silicone rubber is physiologically inert. Gale and his coworkers compared the tissue reactions caused by the implantation of catgut, cotton, polyethylene, Ivalon (polyvinyl plastic), and silicone rubber. The reaction produced by the silicone rubber was "least and practically nonexistent."[34]

The silicones have been found useful in many fields of surgery. They have been used for prosthetic heart valves[35] and as an artificial heart-lung machine.[32] Permanent silicone rubber tube implants have been employed for relief of hydrocephalus.[37-39] Dr. Eugene Spitz of the Children's Hospital of Philadelphia is considered to be one of the pioneers in the surgical treatment of hydrocephalus patients. He has been employing silicone tubing and believes it to be the most suitable material used to date.[40] These tubes have remained functioning up to four years at the time of this report. It seems reasonable to assume that, if cerebral tissues can tolerate silicone rubber, the eye may also.

Silicone rubber has been used as a permanent urethra[41] and also as a prosthesis or stent for repair of bile ducts. At the Lahey Clinic the material has been left in bile ducts up to five years. Dr. Richard B. Cattell reports that he "saw no evidence of toxicity or change in the mucosa of the bile duct in contact with the silicone tubing."[42]

Preliminary study

The purpose of the first part of this investigation was to verify the previous reports concerning the inertness and low toxicity of silicone rubber.

Segments of silicone rubber (manufactured by Dow-Corning) were injected intracorneally, subconjunctivally, and into the anterior chambers of rabbit eyes. Twelve eyes were injected by each route and the results compared with the opposite eyes which were injected with polyethylene (obtained from Clay-Adams, Inc., of New York).

The mode of injection was as follows:

A No. 22 gauge needle with stylette was first inserted into the corneal stroma, superficially, three mm. from the limbus. The stylette was then removed and the piece of silicone rubber measuring 0.75 by 2.0 mm.

was placed into the needle. The stylette was then used to push the silicone rubber into proper position in the cornea. The anterior chamber injections were made similarly, using the same sized plastics. Larger pieces were used in the subconjunctival injections.

Results of preliminary study

Clinically, the rabbits with the silicone rubber showed similar or less inflammatory reaction than those with the polyethylene. The inflammatory reaction was slight in both series. Pathologic studies will be included in future reports. One property of the silicone was especially interesting; frequently the silicone rubber would be seen lying freely on the anterior iris surface. Thus, when the rabbit's head was rotated, the particle of silicone rubber would float to the opposite side of the anterior chamber. In marked contrast the polyethylene tended to become adherent to the iris or cornea.

Main phase of research

The main portion of this study was concerned with the surgical implantation of silicone rubber tubing into rabbit eyes. It is obvious that the implant must be permanently fixed in position so that it will not move forward, farther into the anterior chamber, or backward and out of the anterior chamber. The implanted material should also be immovable. Inadequate fixation may cause mechanical irritation and inflammation in the eye, with subsequent fibrosis and loss of filtration.

Material for implantation

Carefully cured silicone rubber tubing made by Dow-Corning (trade name, Silastic) was used. (This tubing is designated as S-2000.) The material is translucent to transparent in appearance. The inside diameter of the tube used was 0.86 mm. and the outside diameter 1.27 mm. The tubes varied from 8.0 to 12 mm. in length (fig. 1-a). After many trials with various methods, it was believed that fixation of the tube would be insured by altering or refashioning its shape prior to insertion. A four-mm. length of three quarters of the wall of the lumen in the midportion of the tube was cut off. This resulted in a complete tube at either end, connected with a flat central segment four mm. long (fig. 1-b). The end of the tube to be placed into the anterior chamber was also beveled.

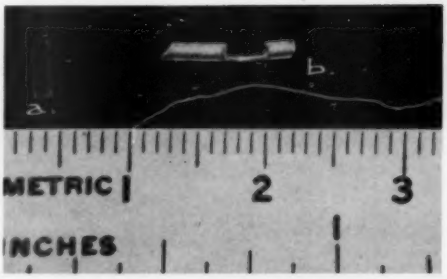

Fig. 1 (Ellis). (a) Silicone rubber tube used for implantation. (b) Horizontal plastic material on right shows result of reshaping so that central segment is flat.

Surgical implantation

During the surgical procedure, the flat segment of the silicone was placed under a previously dissected scleral flap or tunnel (fig. 2-A and A′). The tip of the tube placed in the anterior chamber was beveled to avoid contact between the tube and the posterior corneal surface. The tubular portion anterior to the flat segment, because it was larger, would prevent slippage of the tube posteriorly or out of the anterior chamber. Similarly, the larger tubular portion in the posterior part of the tube would prevent slippage anteriorly or farther into the anterior chamber.

Surgical technique

Albino rabbits were placed under general anesthesia with intravenous Nembutal (pentobarbital sodium). A retrobulbar injection of two cc. of two-percent procaine was also given. The conjunctiva and Tenon's fascia were incised over the superior globe about 12 mm. from the limbus. This resulted

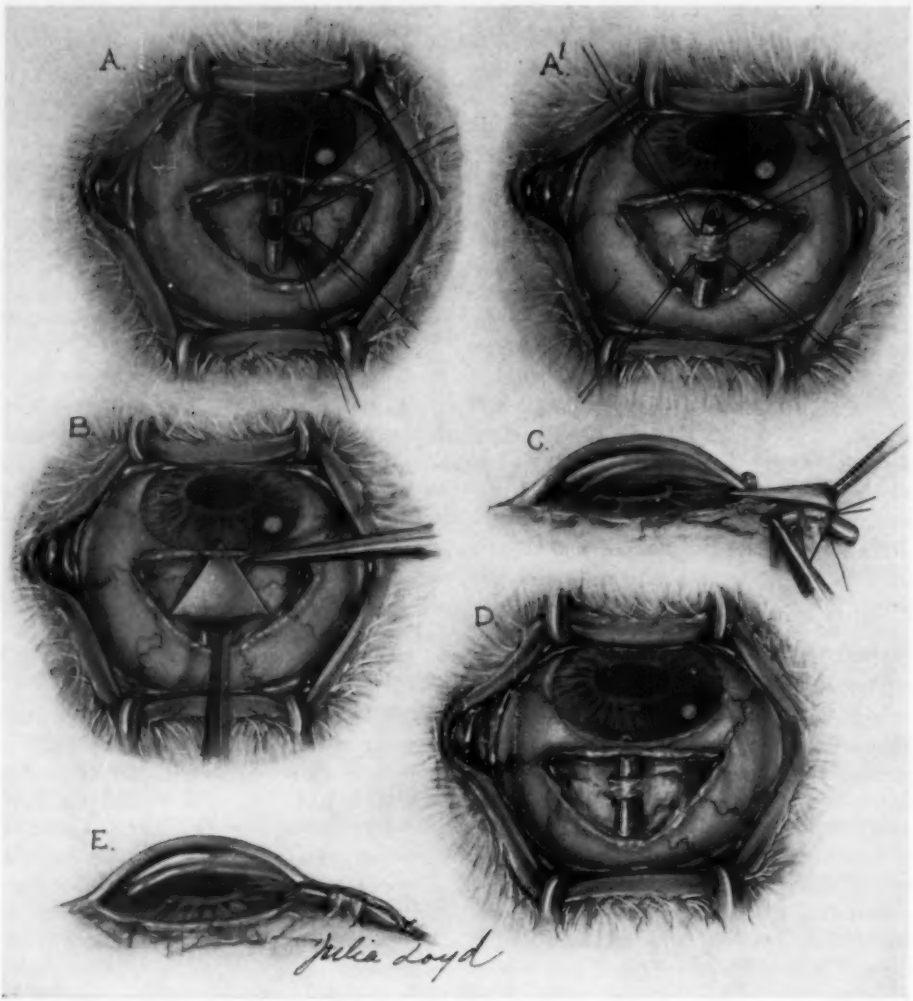

Fig. 2 (Ellis). Method of implantation. (A) Silicone rubber tube being placed under pedicle scleral flap at the 12-o'clock meridian. (A′) Alternate, though similar, method of implantation, that is, insertion of implant under previously dissected scleral tunnel. (B) Chamber is then entered with keratome while forceps holds silicone rubber tube to one side. (C) Horizontal view, showing keratome incision. (D) Silicone rubber tube is in place with bevelled end just within anterior chamber. Previously place scleral sutures are then tied. (E) Horizontal view with tube in position and conjunctiva finally sutured.

in a large limbal-based flap which was reflected over the superior cornea. Then a four-mm. long scleral tunnel was dissected (fig. 2-A′). The tunnel was wide enough to admit the tube and extended from three to four mm. from the limbus at one end to about eight mm. from the limbus at the opposite end. An alternate, though similar, procedure consisted in dissection of the sclera into a pedicle flap with the same dimensions and in the same location as the tunnel (fig. 2-A).

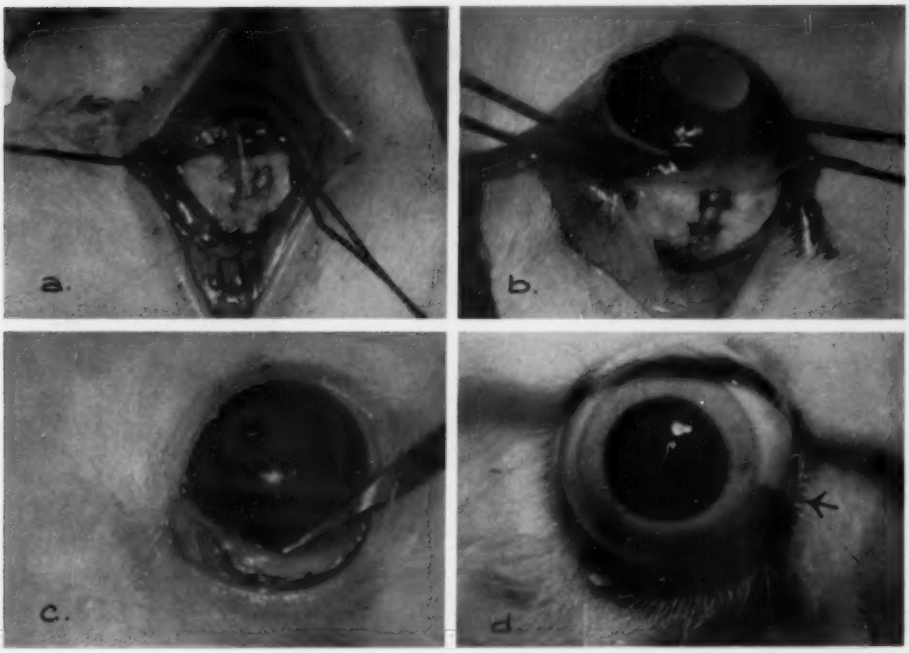

Fig. 3 (Ellis). (a) Scleral tunnel dissection and silicone rubber tube being inserted at the 12-o'clock meridian. (b) Scleral sutures have been tied and flat central segment of tube is buried under sclera. (c) Immediate postoperative appearance, showing large conjunctival bleb superiorly at the 12-o'clock position. (d) Photograph taken three months postoperatively, showing filtering bleb (arrow) and minimal reaction to implant.

The silicone rubber tube was then passed under the scleral flap or tunnel so that the flat segment of the silicone rubber would be covered by scleral tissue (figs. 2-A, A′, and 3-a). A mild chromic 6-0 gut suture was placed through each of the four corners of the scleral tunnel or pedicle but not tied. The anterior chamber was then entered with a keratome, starting 1.5 to 2.0 mm. from the limbus (figs. 2-B and C) and the bevelled end of the silicone tube was placed into the anterior chamber for a distance of 0.5 mm. or less. The previously placed 6-0 catgut sutures were then tied, securely anchoring the scleral flap over the flat segment of the tube (figs. 2-D and 3-b). No sutures were passed through the silicone rubber implant. The conjunctiva and Tenon's fascia were then closed with gut sutures (figs. 2-E and 3-c). This procedure was performed on 40 rabbit eyes.

Results

One day postoperatively the eyes exhibited slight-to-moderate injection of the conjunctiva in the area of the implant. The corneas were clear except for faint haze usually limited to a three-to-four mm. zone adjacent to the silicone rubber tip in the anterior chamber. This was due to localized edema of the cornea. Immediately after surgery the anterior chambers were flat. Surprisingly, within 48 hours they formed in the great majority of cases but were often shallow. The pupils reacted normally.

Within seven days the injection of the conjunctiva gradually subsided. The localized corneal haze also gradually decreased and within two weeks the cornea was clear

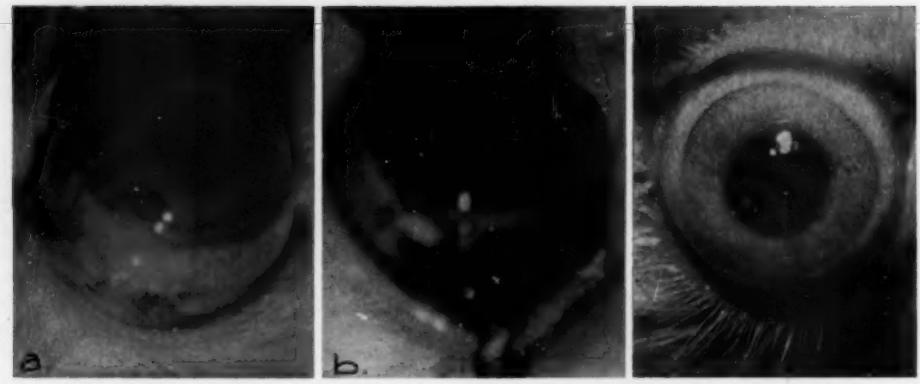

Fig. 4 (Ellis). (a) Silicone rubber tube in place four months after surgery. Filtering bleb is seen in foreground. (b) Methylene-blue dye has just been injected into the anterior chamber and may be seen draining to the large bleb at the 12-o'clock position. (c) Eye in which tube has slipped out of position and far into anterior chamber four months postoperatively. However, the eye exhibits minimal reaction.

except for a localized very faint opacity and a few vessels overlying the tip of the tube. This opacity usually measured no more than 1.0 by 2.0 to 2.0 by 3.0 mm. It frequently was difficult or impossible to see the tip of the silicone tube in the anterior chamber because of (1) its translucent to transparent property, (2) the location of the tube just inside the angle of the anterior chamber, and (3) the overlying localized faint corneal opacity.

In four eyes the cornea cleared completely after three weeks, leaving only a few vessels at the limbus. Even in these eyes, it was difficult to see the small silicone rubber tip. Frequently the iris surface was seen to flatten for two to four mm. in the region where the tube entered the anterior chamber.

A large diffuse filtration bleb was seen immediately postoperatively. The bleb gradually became smaller after two to four months (fig. 4-a). Finger pressure on the globe caused the bleb to enlarge. Further proof that filtration was taking place was furnished by injecting 0.02-percent methylene blue into the anterior chamber of these eyes. The blue color was then seen to travel from the anterior chamber to the subconjunctival bleb (fig. 4-b).

The main complication occurred after two to four months in 20 cases. In these eyes the implants then moved either anteriorly farther into the anterior chamber or posteriorly completely out of the anterior chamber. It was thought that this slippage occurred for two reasons: (1) the sclera was apparently slower in healing than the catgut sutures were in absorbing and (2) the nonadhesive or nonadhering quality of the silicone rubber. It was interesting to note that the silicone tubes, even when they slipped far into the anterior chamber, caused very little, if any, inflammatory reaction (fig. 4-c).

Comment

Any foreign material placed in the eye is unphysiologic and will cause some inflammatory reaction. The results of this present study seem to indicate that silicone rubber causes a minimal reaction which the eye can tolerate. The small faint localized limbal vascularized scar seems to be a small price to pay if permanent aqueous drainage can be maintained.

The main failure of this work was the slippage or movement of the silicone rubber tubes. This probably occurred because of the nonadhesive quality of silicone rubber and the slow healing of the sclera. Future research will be directed to eliminate this

TABLE 1

FOREIGN MATERIAL IMPLANTATION IN GLAUCOMA SURGERY: A SUMMARY

Year	Investigator	Method
1906	Rollet and Moreau	Horsehair paracentesis
1907	Rollet	Horsehair paracentesis
1912	Zorab	Silk thread: anterior chamber to subconjunctiva
1912	Mayou	Silk thread: anterior chamber to subconjunctiva
1913	Zorab	Silk thread: anterior chamber to subconjunctiva (Aqueoplasty)
1913	Mayou	Silk thread: anterior chamber to subconjunctiva
1915	Wood	Silk thread: anterior chamber to subconjunctiva
1915 (1907)	Vail	Silk thread; vitreous to Tenon's space
1922	Weekers	Gold cuff through scleral trephine: vitreous to Tenon's space
1925	Stefansson	T-shaped gold (wire, tube or solid gold): anterior chamber to subconjunctiva
1934	Row	(1) Platinum-iridium wire in cyclodialysis cleft (2) Horsehair in cyclodialysis cleft
1936	Wolfe and Blaess	Silk thread: anterior chamber to subconjunctiva
1940	Troncoso	Magnesium sheet implant in cyclodialysis cleft
1942	Gibson	Lacrimal canaliculus: anterior chamber to subconjunctiva
1949	Bick	Tantalum plates and tubes: anterior chamber to subconjunctiva; also in cyclodialysis clefts
1949	Troncoso	Tantalum-foil tube, tantalum sutures and tubes: anterior chamber to subconjunctiva via trephination and also in cyclodialysis clefts
1951	Muldoon, et al.	Platinum wire: anterior chamber to subconjunctiva
1951	Haberberger	Protoplast loop through Elliot trephination
1952	Losche	Hollow Supramid in cyclodialysis cleft
1954	Qadeer	Acrylic plates: anterior chamber to subconjunctiva
1955	Bietti	Polyethylene tube in cyclodialysis cleft
1955	Laval	Gelfilm in iridencleisis operation
1956	Teulières	Catgut used to keep scleral wound open
1956	Strampelli	Supramid thread in cyclodialysis cleft
1958	Stone	Tantalum tube: anterior chamber to subconjunctiva
1958	Barsky and Schimek	Gelfilm in cyclodialysis clefts
1958	La Rocca	Polyvinyl tube: anterior chamber to subconjunctiva
1959	Lehman and McCaslin	Gelfilm: anterior chamber to subconjunctiva

problem by using a tube composed of silicone rubber at one end and Dacron (± mesh) at the other end. The plastic, Dacron, has been successfully used as a synthetic vascular substitute, replacing diseased portions of vessels.[43, 44] DeBakey and his coworkers have used various sized Dacron tubes in the surgical treatment of aortic and arterial diseases in 737 cases since 1957.[44] They believe Dacron to be superior in all respects to other synthetic vascular replacements and homografts.

In future glaucoma research the Dacron end of the implant will be incorporated in the sclera, using the method described in this series of animal experiments. However, it is hoped that fixation will be guaranteed when the scleral tissue grows into the Dacron. Strips of sclera will also be placed through the Dacron end of the tube and silk sutures used to aid in permanent fixation.

In the neurosurgical treatment of hydrocephalus, Dr. Eugene Spitz and others have used silicone rubber valves.[40] This permits only unidirectional flow of cerebrospinal fluid to the venous system. The valve also regulates the flow so that it functions only after the cerebrospinal fluid pressure is elevated to 35 mm. H_2O. More than 1,200 of these valves, which were designed by Dr. Spitz, are being used each year in neurosurgery. If the silicone-Dacron tube implantation in animal eyes proves to be successful, future research with a valve will be

pursued. However, proper immobilization of the implant and acceptance by the eye is of primary importance in this glaucoma surgery.

It is obvious that this problem is still unsolved and that any seton operation, being unphysiologic, will not replace surgery now employed for glaucoma. However, it is hoped that from this research will be evolved a surgical procedure that will be useful in those glaucoma cases in which many previous surgical procedures have failed.

Summary

The literature concerning attempts at implanting various materials in the eye to relieve glaucoma has been reviewed. Preliminary studies showed that the plastic, silicone rubber, is inert.

The method of implantation of silicone rubber tubes for the surgical treatment of glaucoma herein described has been performed on rabbit eyes. Movement of the tube occurred in two to four months in 20 of the 40 rabbit eyes. A change in technique to eliminate this complication in future animal studies has been described. Even if successful, this surgery should be limited only to glaucoma cases in which all other medical and surgical treatment has failed.

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EXPERIMENTAL HYPHEMA IN RABBITS*

II. The effect of acetazolamide (Diamox) on the rate of absorption

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In previous studies using CR^{51}-tagged red cells, it has been shown that mydriatics and miotics have no detectable effect on the rate of absorption of hyphema in the rabbit.[14] In an attempt to find a drug which could conceivably affect the absorption of red blood cells from the anterior chamber, acetazolamide (Diamox, Lederle & Co.) was selected for use because of its known effect on the secretion of aqueous.[6, 10, 12]

Methods and Materials

Experimental animals and techniques similar to those used in the previous study[14] were employed for the labelling of the red cells, injection into the anterior chamber, and obtaining and counting the peripheral blood specimens.†

Diamox was prepared and used as follows: Diamox in parenteral form was reconstituted with sterile water so that 0.5 cc.

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† Rabbits were used throughout the study. One eye only of each rabbit was used. Whole rabbit blood, plus ACD solution[18] and heparin, was incubated at 80°F. (plus or minus 2°F.) for 90 plus minutes with 200 μc. Cr^{51} per 3.5 cc. whole blood. After washing at least three times with Ringer's solution, the uptake of Cr^{51} in the cells was "fixed" by the addition of six (plus or minus) mg. ascorbic acid per 3.5 cc. whole blood. Tagged cells, 0.05 cc., were injected into the anterior chamber of the rabbit's eye after the removal of 0.05 cc. aqueous humor, using a 27-gauge, one-inch needle. Peripheral blood specimens were obtained by bleeding from an ear vein at 3, 5, 7, 24, and 48 hours after injection of the tagged cells into the anterior chamber. All blood specimens were counted in a deep-well scintillation counter.

contained the desired single dosage. Four injections of 0.5 cc. each were made as follows: Intravenous, in the ear vein, 90 minutes before induction of the hyphema; intravenous, three hours after induction of hyphema; intramuscular, in the hind leg, seven hours after induction of hyphema; intramuscular, 24 hours after induction of hyphema.

In early phases of these experiments the controls were not injected with an analog of Diamox, though this was done in most of the series. Sulfadiazine, an analog of Diamox, was injected, in comparable doses, into the controls at the same time and in a corresponding manner as the intravenous Diamox in all series except as noted under results.

The duration of each experiment was 48 hours after the induction of the hyphema. All animals were killed at this time and disposed of according to radiation safety regulations. The radioactive count on the peripheral blood was adjusted to the hematocrit of the individual specimen.

Standard and percent absorption

The counts per minute on 1.0 cc. of the tagged blood injected into the anterior chamber were obtained for each experimental run in each series. The counts per minute on each peripheral blood specimen were reduced to a percent of this standard and designated as *the* percent absorption of the hyphema at seven, 24, and 48 hours after induction of the hyphema. The blood dilution factor was considered to be a constant since it fell within acceptable statistical limits of variability. Each individual percent absorption, from zero to seven hours, seven to 24 hours, and 24 to 48 hours, was plotted on square root graph paper. The resultant curves were plotted on linear graph paper (fig. 1). The percent absorption figures for all animals in each series of experiments, at the above time intervals, were subjected to the rank sum and t test, and the percent difference of absorption between the treated animals and the controls was calculated by the Department of Biostatistics, University of California Los Angeles Medical Center, under the supervision of Wilfrid J. Dixon, Ph.D.

Results

Macroscopic observations of the hyphemas during the course of these studies were made and found to be of no value in evaluating the rate of absorption of the red blood cells. Consequently, all studies relied on the objective measurement of Cr^{51}.

Series of controlled experiments were done to determine the minimum, maximum and optimum effective dosage range of Diamox. A total of 342 animals was used, 173 Diamox-treated, 169 controls in nine series according to dosage.

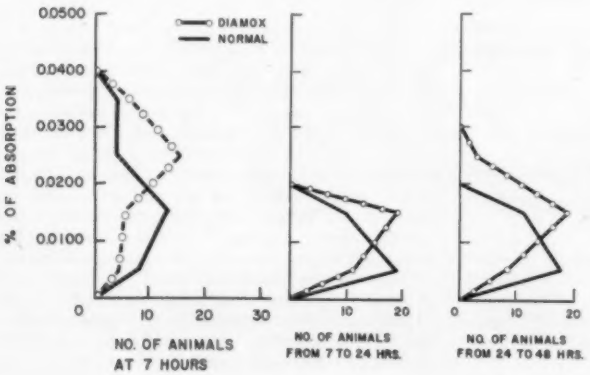

Fig. 1 (Sinskey and Krichesky). The rate of absorption of tagged red blood cells in rabbits treated with Diamox, as compared to normals.

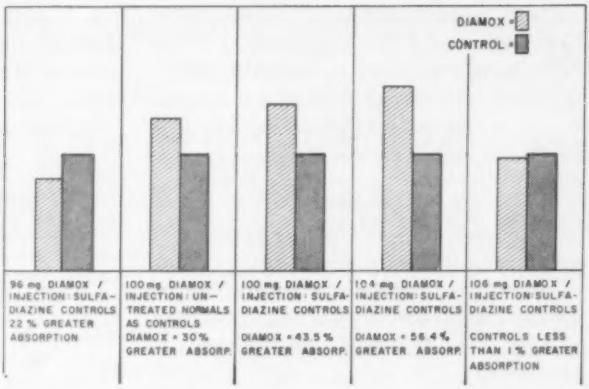

Fig. 2 (Sinskey and Krichesky). Comparison of the rate of absorption between Diamox-treated and control rabbits at 24 hours at four dosage levels.

SERIES 1

Diamox, 17 animals, 50 mg. per injection; 16 controls, untreated. Statistically there was no significant difference in rate of absorption between treated and control animals.

SERIES 2

Diamox, 12 animals, 75 mg. per injection; 12 controls, untreated. Statistically there was no significant difference in rate of absorption between treated and control animals.

SERIES 3

Diamox, 11 animals, 90 mg. per injection; 12 controls, untreated. Statistically there was no significant difference in rate of absorption between treated and control animals.

SERIES 4

Diamox, 17 animals, 96 mg. per injection; 17 controls, sulfadiazine, 96 mg. The control group showed a 21.93-percent higher absorption rate than the Diamox group.

SERIES 5

Diamox, 30 animals, 100 mg. per injection; 29 controls, untreated. The Diamox group showed a 30.0-percent higher absorption rate than the control group at 24 and 48 hours.

Diamox, 12 animals, 100 mg. per injection; 12 controls, sulfadiazine, 100 mg. The Diamox group showed a 43.5 percent higher absorption rate than the control group at 24 and 48 hours.

SERIES 6

Diamox, 18 animals, 104 mg. per injection; 15 controls, sulfadiazine, 104 mg. The Diamox group showed a 56.4-percent faster absorption rate than the control group at 24 and 48 hours.

SERIES 7

Diamox, 22 animals, 106 mg. per injection; 22 controls, sulfadiazine, 106 mg. Statistically there was no significant difference in rate of absorption between treated and control animals.

SERIES 8

Diamox, 11 animals, 125 mg. per injection; 11 controls, untreated. Statistically there was no significant difference in rate of absorption between treated and control animals.

SERIES 9

Diamox, 23 animals, 200 mg. per injection; 23 controls, untreated. Statistically there was no significant difference in rate of absorption between treated and control animals.

DISCUSSION

The results show that the minimum effective dosage of Diamox is 100 mg. per injection $\times 4$. The maximum and optimum effective dosage, as found in this study, is 104 mg. per injection $\times 4$ (fig. 2). It is quite remarkable that the dosage level has such a critical range of effectiveness, being only 4.0 mg. $\times 4$. Of significance also is the observation of Dr. Becker that, in rabbits, any dosage of Diamox below 100 mg. per initial injection is ineffective in altering aqueous humor.[2, 3]

It is difficult to determine by this study alone why Diamox is effective in increasing the rate of absorption of red blood cells from the anterior chamber. Clinically, we do observe that the absorption of hyphemas is retarded by an elevation in intraocular pressure. Perhaps, the inhibition of aqueous formation produced by Diamox allows the red blood cells to move through the trabeculae into Schlemm's canal in a more orderly fashion, whereas, if the red blood cells com-

pete with normal outflow of aqueous, the absorption would be decreased. Further studies using tonometry in conjunction with tagged red cells may shed additional light on the reason Diamox is effective and why it is effective in such a narrow range.

Summary

1. The use of Diamox in experimental hyphemas increases the rate of absorption of red blood cells from the anterior chamber of rabbits up to 56 percent in a 24-hour period.

2. The effective dosage level of Diamox is quite critical.

3. The pharmacologic and physiologic explanation for the relationship between effectiveness of Diamox and hyphema and its critical dosage range demands further study.

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PROPHYLAXIS IN TRAUMATIC HYPHEMA

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The occurrence of bleeding into the anterior chamber after contusion of the globe can present, on occasion, an intractable condition. While it is true that there is uneventful recovery in many cases of hyphema, a certain number of eyes have a low residual visual acuity or are entirely lost. Much emphasis has been placed on the presence of blood in the anterior chamber with particular stress on the management of secondary hemorrhage. However, stressing the mechanisms preceding the secondary bleeding and relating this to the disturbed physiology lead me to offer a concept. Blood vessel interruption in the presence of lowered intraocular pressure is essential in hyphema. The ratio of the pressure in the blood vessels to the pressure in the globe is disturbed and the torn blood vessel spills blood into the anterior chamber. It is only when a great quantity of blood is introduced into the anterior chamber that a second rise in pressure takes place. The blood in the anterior chamber and the increase in intraocular pressure now spell disaster to the eye.

The following case illustrates how an eye may be lost because of hyphema and its sequelae:

A six-year-old girl was shot in the left eye from a great distance with a BB pellet. At the initial examination the pellet was found in the lower cul-de-sac, rolling to the floor as the lower lid was everted. The cornea and anterior chamber were normal. It was thought that there was a minimal clot at the 7-o'clock position. Vision was 20/20.

As this case preceded the present concept, no further studies were done. With considerable firmness I minimized the injury, as did the patient's parents and the marksman's parents. On the fourth day the patient reappeared with an anterior chamber filled with blood, complaining of much pain. She was hospitalized and given sedation, hot compresses, Adrenosem injections, vitamin C, and vitamin K. Pain subsided and the cornea remained blood stained.

At the end of two years, the blood stain was sufficiently translucent to make out what was thought to be the pupillary opening. At the end of two additional years, the eye was soft and ciliary injection was present. The patient had blepharopexy and light projection was faulty.

It was decided to do an evisceration, during which it was noted that the iris had rolled into a small mass at the upper temporal quadrant. The lens capsule had become calcified, empty of cortex and the blade of a Graefe knife rang as it stroked the capsule. This result left much to be desired.

The blood vessels of the eye may be conceived as forming a basket of interlacing branches. The anterior ciliary arteries have connections with the episcleral limbus and the anterior conjunctival arteries which terminate in the ciliary body, major circle of the iris, and the anterior choroidal vessels. These vessels are vulnerable in any blow of low velocity to the globe. The mere observance of blood in the anterior chamber without relating it to the changes in intraocular pressure is not so revealing as tonometric studies. It has been observed in the cases here presented that contusion of the globe may occur without interruption of blood vessel continuity but with a considerable fall in intraocular pressure. This is demonstrated in Cases A and B. In the absence of interruption in the continuity of a blood vessel, hyphema did not occur. It has been observed that there may be a rise in intraocular pressure immediately after injury which, in about four days, may be followed by a fall in intraocular pressure. While an initial rise in tension may conceal or perhaps minimize blood vessel injury, the subsequent fall in tension will permit the higher blood vessel pressure in the vascular basket of the eye to spill blood into the anterior chamber. Hyphema is the physical sign of blood vessel interruption and, in my opinion, denotes an increase in the ratio of blood vessel pressure to intraocular pressure in the presence of a torn blood vessel.

Gillan[1] calls attention to the reduction in intraocular pressure in all traumatized eyes. Spalter[2] notes that, when the intraocular

pressure falls from an attained high systolic value, blood again enters the eye. Duke-Elder[3] has commented that tearing of the sclera occurs in the inner layers first. With a contusion the wall of the eye is indented and a shearing stress is set up, permitting the choroid to slide on the inner wall of the sclera and thereby compromising blood vessels at the root of the iris or ciliary body.

If the initial lesion in the blood vessel can be controlled early in the injury, the sequelae of uncontrolled hyphema may be averted. Thygeson and Beard[4] report that the major complication of traumatic hyphema is glaucoma, secondary to the secondary hemorrhage. This occurred in seven of their 34 cases.

It would be advantageous to see a patient early after the onset of hyphema. It is then that the source of the bleeding can be related to the angle of the anterior chamber. After an anterior chamber has filled with blood, it is difficult to recognize the source of bleeding. When the anterior chamber is opened to evacuate a clot, the source of bleeding may be detected.

If the patient presents with an anterior chamber completely filled with blood and increased intraocular pressure, the time for control by localized diathermy alone is passed. In the presence of hyphema any lesion not the result of the disturbance in ratio between blood vessel pressure and intraocular pressure is not included in this form of therapy.

Wilson, McKee, Campbell, and Miller[5] noted the need to prevent secondary hemorrhage into the anterior chamber. Only 27 of their 36 cases treated by air injection were seen before secondary hemorrhage. Two of the latter developed secondary hemorrhage. They point out that one factor that may cause such severe bleeding is hypotony following contusion of the globe. They injected air to act as a cushion to prevent secondary hemorrhage; the air was their means of increasing the intraocular pressure. When the period of bleeding is considered to be somewhere between the second and fifth day and the air may be absorbed in two to four days, re-injection may be needed for safety's sake. I agree entirely with these authors that operation should be done early before blood staining of the cornea occurs and before severe iritis develops. However, it is my opinion that coagulation with localized diathermy is less traumatizing to the globe than corneal incisions.

Loring[6] presents a series of 56 cases of hyphema and agrees that between the second and fifth days there may be secondary hemorrhage. He also points out that most contused eyes after a transient period of hypertension become hypotensive. Loring also significantly states "since the complications are so frequent (30 percent) and the visual results so poor in a high percentage of these cases, I feel that treatment, even if only expectant or prophylactic, should be instituted." I am in accord with this statement.

Technique

Thygeson and Beard[4] point out that there is no general agreement as to the best method to treat hyphema. In a review of the literature on traumatic hyphema, Kushner[7] comments on therapy and states that hot or cold compresses, fibrinolytic agents, agents affecting blood coagulation, steroids, and air injection into the anterior chamber are of questionable value. No mention is made of early treatment of the source of bleeding by diathermy coagulation. Diathermy has been employed in treating glaucoma,[8] angiomatosis retinae,[9,10] Eales' disease,[11] von Hippel's disease,[12] and traumatic hyphema.[13]

The treatment here presented is as follows:

After the examination has been made, it is decided whether to use local or general anesthesia. Inquiry is made as to when the patient has last eaten, since a general anesthetic may have to be postponed. Preanesthetic medication is then given. Intravenous pentothal sodium anesthesia and two-percent solution of Pontocaine topically are best. The intraocular pressure in both eyes is deter-

mined. A retrobulbar injection of one-percent solution of Xylocaine containing epinephrine (1:100,000) is then given. A wet sponge is held against the closed lids with enough pressure to diffuse the solution in the muscle cone. The tension in the eye has now dropped. Further inspection may reveal additional injury. Where the most blood is visible is not necessarily the source of bleeding.

As a source of diathermy a Hyfrecator, a Bovie unit, or any of the well-known machines used in ophthalmologic procedures (for example, a Walker), may be employed. An inactive electrode is then attached. The active electrode is a curved shielded electrode exposed for a 1.5 mm. at the end. This will penetrate the conjunctiva and reach the outer layers of the sclera. The machine is set to run seven seconds. The current is set on the dial at 40 on the Hyfrecator and 15 on the Bovie unit. A point six mm. behind the limit of the anterior angle is selected. The area of bleeding is coagulated with four puncture points. If bleeding occurs in the next 24 hours, the vessel has been missed or there is another pathologic process which is not amenable to localized diathermy. If the vessel has been missed, the procedure should be repeated at a new location. An aureomycin ointment dressing is placed over one eye and the patient is put to bed. In the management of these patients with hyphema, no reliance was placed on cycloplegics or miotics. None of the blood coagulants were employed. No physical agents in the form of hot or cold compresses were used.

Report of cases

Case 1

A man, aged 35 years, was struck in the left eye by a branch of a bush while chasing a pig. He had pain in the eye, with slight subconjunctival hemorrhage. There was slight hyphema. On examining the cornea with the patient leaning face down, it was observed that, while the greater mass of blood was displaced to the center of the cornea, there was a persistent strand of blood from the 6-o'clock position. It was thought that this position was the origin of the bleeding and that a radial vessel of the iris was involved.

A two-percent solution of Pontocaine was instilled into the eye and, with the patient in a recumbent position, a retrobulbar injection of a two-percent solution of procaine containing epinephrine (1:100,000) was given. There was good anesthesia and akinesia. The tension decreased from 40 mm. Hg (Schiøtz) to 16 mm. Hg.

An electrode, such as is used for cyclodiathermy, was attached to a Hyfrecator apparatus. An inactive electrode attached the self-retaining lid speculum to the other lead of the machine. The machine was set at 40 on the dial. Four intrascleral points seven mm. behind the limbus at the 6-o'clock position were coagulated for seven seconds. There was no recurrence of bleeding.

Three weeks later the tension was 20 mm. Hg (Schiøtz) and the uncorrected vision was 20/15. This result suggested that, if localized diathermy were used to seal the area of bleeding in the vessels that cross the iris root, the ophthalmologist would have a means of controlling hyphema.

Case 2

A school boy, aged 16 years, was struck in the right eye when a companion threw a small, hard, unidentified object. There was pain in the eye and photophobia; vision could not be properly recorded. After instillation of a 0.5-percent solution of Pontocaine, it was apparent that there was a small superficial abrasion of the corneal epithelium which stained with two-percent fluorescein. There was a small hyphema. The pupil was three-mm. wide and slightly flattened at the 8-o'clock position. Tension was 30 mm. Hg (Schiøtz).

The patient was admitted to the hospital and under intravenous pentothal sodium, a two-percent solution of Pontocaine was instilled into the right eye and a retrobulbar injection of 1.5 cc. of one-percent Xylocaine solution with epinephrine (1:100,000) was given. The tension decreased to 14 mm. Hg (Schiøtz). Localized diathermy was performed as in Case 1, paralleling the limbus at the 7- to 8-o'clock position. During the course of the next seven days there was no further bleeding, and the tension was 19 mm. Hg (Schiøtz). Uncorrected vision was 20/20 on the 14th day.

Case 3

A man, aged 50 years, was struck in the left eye with the heel of a woman's shoe. The blow came from above downward and it struck the left eye at the 12-o'clock position. The lower lid was everted and a small notch torn from the lid border. At the 8-o'clock position a small pear-shaped mass of blood hung downward. The pupil was flattened at the 12-o'clock position and measured four mm. as compared to two mm. in the right eye. The source of the bleeding seemed to be from the 8-o'clock position.

The patient was hospitalized and under intravenous pentothal sodium anesthesia, a two-percent solution of pontocaine was instilled into the left eye. A retrobulbar injection of 1.5 cc. of one-percent Xylocaine solution with epinephrine (1:100,000) was given. The tension decreased from 36 mm. Hg (Schiøtz) to 19 mm. Hg. It was now apparent,

however, that the pear-shaped mass of blood had doubled in size. A keratome incision was made at the 8-o'clock position and, with a wet cotton wipe, the blood clot was evacuated. This procedure was followed by localized diathermy seven mm. behind the limbus at the 8-o'clock position. A 6-0 black silk suture was used to close the wound.

In 24 hours, when the bleeding had not subsided and the anterior chamber again held blood, it was noted that the strands of blood were from the 12-o'clock position. Additional localized diathermy was placed at the 12-o'clock position. The patient made an uneventful recovery. Uncorrected vision at the end of three weeks was 20/20; the tension was 20 mm. Hg (Schiøtz).

CASE 4

A school boy was struck in the left eye with an extended finger during a football scrimmage. The point of impact seemed to be located nasally, producing a small subconjunctival hemorrhage at the 9-o'clock position. When seen in the emergency room, the patient complained of pain, photophobia, and reduction of vision. Vision in the left eye was hand movements only. There was corneal edema. Definite, although slight, hyphema was present.

Under intravenous pentothal sodium anesthesia, a two-percent solution of pontocaine was instilled into the left eye and 1.5 cc. of one-percent solution of Xylocaine containing epinephrine (1:100,000) was injected retrobulbarly. The tension decreased from 50 mm. Hg (Schiøtz) to 22 mm. Hg. At the 9-o'clock position, seven mm. behind the limbus, localized diathermy was performed in three places. There was no further bleeding. Uncorrected vision was 20/20; the tension, 20 mm. Hg.

CASE 5

When an 11-year-old boy tried to protect his younger brother from maternal chastisement, he received the full impact of a strap lash across the left eye. When seen three hours later, some redness and edema of the lids, slight subconjunctival hemorrhage, and a thin ooze of blood in the anterior chamber, from the 9-o'clock position downward toward the 6-o'clock position, were noted. There was photophobia, with no elevation of tension on finger palpation and no apparent edema of the cornea.

The patient was admitted to the hospital and under two-percent intravenous pentothal sodium anesthesia, a two-percent solution of pontocaine was instilled into the left eye. A retrobulbar injection of a one-percent solution of Xylocaine containing epinephrine (1:100,000) was given. During the setting up of photographic equipment, it became apparent that the bleeding was increasing slowly. At a point six mm. behind the limits of the anterior chamber, localized diathermy was performed; a 20-gauge hypodermic needle was held with a mosquito clamp which was touched by the active electrode of the Bovie unit. The machine had been set at the 15 mark. As a precaution, two other points at the 7:30- and 6-o'clock positions were also treated. Two drops of a two-percent solution of homatropine were then instilled into the eye.

Recovery was uneventful, there being no further bleeding. Uncorrected vision was 20/15, 14 days later.

CASE 6

A man, aged 35 years, while attempting to open a bottle of champagne, was struck from below by the cork, receiving a contusion of the right lower lid and a small hyphema. Examination within the hour showed an ecchymosed right lower lid margin and a horizontal blood clot in the anterior chamber at the 6-o'clock position. The patient complained of pain and poor vision. The pupil was in mid-dilation and fixed. Uncorrected vision was 20/30, while the left eye had 20/20. The patient was admitted to the hospital where intravenous pentothal sodium was administered. Topical two-percent Pontocaine solution was instilled in the eye and the Schiøtz tension was 35 mm. Hg, R.E., 18 mm. Hg, L.E. High initial readings have frequently been noted in contused eyes. A retrobulbar injection of 1.5 cc. of two-percent Xylocaine solution containing epinephrine (1:100,000) was given. Four points at the 6-o'clock position, six mm. from the chamber angle, were then coagulated for seven seconds, the Walker diathermy machine being used.

Twelve hours later the anterior chamber showed a blood clot of about one-half the original size. Rapid reduction in clot volume has frequently been noted after this procedure.

The patient made an uneventful recovery, with a final tension of 20 mm. Hg (Schiøtz) in each eye and uncorrected vision of 20/20. It was three months before the pupillary movement and size were normal.

CASE 7

A 25-year-old man was playing catcher on a soft ball team and, although he wore a mask, he was struck in the right eye by the ball. He complained of pain and poor vision. His team mates noted blood within the eye. He was hospitalized and placed on complete bedrest. There was no change in the appearance of the blood clot after four days. Tension in the right eye now read 4.0 mm. Hg (Schiøtz) while that in the left eye was 20 mm. Hg. The patient was treated by localized diathermy coagulation. Twenty hours later, reinspection of the eye showed the blood clot to be about one-third the original size. This patient attained normal vision at the end of two weeks and tension was 18 mm. Hg (Schiøtz) in each eye.

CASE 8

A two-year-old boy was struck in the right eye by a toy gun. There was no immediate bleeding. Twenty-four hours later the parents noted that the normally light blue iris was taking on an orange hue. Inspection showed that bleeding was coming from the iris at the periphery of the anterior chamber at the 9-o'clock position. Bright red blood was spilled over the face of the iris and was settling in the iris crypts, more marked temporally.

The patient was hospitalized and under preoperative sedation of 30 mg. Demerol with 1/300 gr. Scopolamine was anesthetized with open ether and intubated. The face and apparatus were covered with a wet towel in preparation for diathermy. Tension was 18 mm. Hg (Schiøtz) in each eye. This is an example of early hyphema without intraocular pressure change. Whether the tension was falling and had not yet entered the lower readings, as compared with the fellow eye, is speculative. Localized diathermy coagulation was done at the 9-o'clock position. The patient made an uneventful recovery. No further tension or visual records were made.

CASE 9

A 10-year-old boy was shot in the left eye with the dart from a toy gun. He complained of pain and poor vision. His mother noted blood within the eye. In the 6-o'clock position there was a blood clot lying horizontally with a camel hump figure at the upper margin. The patient was brought to the hospital and under intravenous pentothal sodium anesthesia, he was intubated. The tension was 30 mm. Hg (Schiøtz) in the injured left eye and 18 mm. Hg in the right eye.

Four points were coagulated at the 6-o'clock position six mm. outside the limits of the chamber angle. At the conclusion of the procedure the tension in the injured eye was 35 mm. Hg. In 12 hours, the clot was one-half its original size; in 36 hours, it was reduced to a mere trace.

On the third day there was no evidence of a clot and the conjunctiva around the area of coagulation had a blanched, edematous appearance. Two weeks later uncorrected vision was 20/20 in each eye.

CASE 10

A 10-year-old boy was shot in the left eye at an estimated distance of four or five feet with a BB gun. The BB pellet was found in the lower cul-de-sac. There was a small abrasion of the cornea at the point of impact, circular in outline and three mm. in diameter. There was blood in the anterior chamber and an iridodialysis at the 3-o'clock position. Diathermy coagulation was done at seven mm. at the 3-o'clock position, one point of the coagulation being placed at each end of the area of torn iris and two near the iris root.

Twelve hours later the iris tear was plainly visible and there was no blood in the anterior chamber. Neither atropine nor eserine was used. A simple eye dressing with aureomycin ointment was used over the injured eye. In 48 hours it became apparent that the iridodialysis was more extensive and that there was beginning bleeding from each end of the attached iris. The patient was again anesthetized and coagulation used at each end of the still-attached iris. It was thought that the sphincter muscle of the iris was contracting and tearing the iris loose. Having observed this phenomenon in Case 1 it was thought best to open the anterior chamber and make a radial iridotomy to eliminate the sphincter action. This was done. Repeated examination showed no further bleeding. Two weeks after the injury, there was no bleeding but there was a coloboma of the iris and cataractous changes in the lens. However, the eye was not destroyed by secondary hemorrhage, blood staining of the cornea, or glaucoma.

CASE 11

A fisherman was struck in the left eye with a lure and developed a traumatic hyphema with a tension of 45 mm. Hg (Schiøtz). Tension in the right eye was 18 mm. Hg. At the conclusion of the coagulating diathermy tension was 18 mm. Hg in each eye. Forty-eight hours later the tension in the injured eye was 10.9 mm. and there was no new bleeding. The old clot was about one third of its previous size.

The eye was dry for the first five days after diathermy when there was renewed oozing from the extremities of the clot. Tension had now fallen to 10.6 mm. Hg. (Schiøtz) and it was feared that the eye would become phthisical. A second diathermic application apparently stopped the bleeding. It seemed that irrigation of the anterior chamber would remove the threat of blood staining of the cornea. This apparently was good judgment. Five days after the second application of diathermy and irrigation of the chamber there was no sign of bleeding.

As examples of low intraocular pressure without hyphema these two cases are added.

CASE A

A carpenter was struck in the left eye with a ricocheting nail. His vision was 20/20 in each eye. Tension was 10 mm. Hg (Schiøtz) in the injured left eye and 20 mm. Hg in the right eye. Without further therapy the tension returned to 18 mm. Hg (Schiøtz) in each eye at the end of two weeks.

CASE B

A 25-year-old man was pulling on a wrench when it slipped and struck him in the left eye with sufficient force to notch the free border of the upper lid. There was reduction in vision to 20/40 and faint ciliary injection. The aqueous ray was negative. A solution of Neohydeltrasol (0.5 percent) was instilled into this eye four times daily. Pain subsided in two days. At the conclusion of one month the tension in the injured eye had risen from 4.0 mm. Hg (Schiøtz) to 20 mm. Hg. There had been no hyphema.

COMMENT

It is possible to have spontaneous resolution of hyphema without medical attention or on bedrest alone. However, since the se-

verity of the injury plays an insignificant part in producing secondary hemorrhage, as was pointed out by Gillan, it is necessary to have a method at hand to prevent the secondary hemorrhage. It would seem logical to conclude that where there is no bleeding there will be no secondary hemorrhage. It is safe practice to apply diathermy to the eye. As a prophylactic procedure against hyphema, even less current and fewer applications are used than in cyclodiathermy for glaucoma.

Summary

The basis for bleeding in hyphema is the difference between the intraocular and the intravascular pressure in the presence of a torn blood vessel. The technique of a prophylactic diathermy coagulation is described. Eleven cases of hyphema treated successfully by this technique are discussed. It is hoped that ophthalmologists will use this technique in their practice so that a greater number of cases may be evaluated.

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Ophthalmic Miniature

c. That, in those who had cut their permanent set, the condition of the incisor teeth was very peculiar, both in form, colour, and size. As diagnostic of hereditary syphilis, various peculiarities are often presented by the others, especially the canines, but the upper central incisors are the test teeth. . . . A few month's observation at any large Ophthalmic Institution will satisfy any one of this clinical fact.

Mr. Jonathan Hutchinson on
Syphilitic Inflamations of the Eye,
Ophthalmic Hospital Reports, **2**:96, 1859.

MINIMAL VALUES FOR THE A AND V SYNDROMES*

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In the study of the strabismus patient, deviation in the vertical meridian has become of increasing interest.[1-3]

The present study was made for the purpose of determining what the values are for the positions of eyes straight-up and eyes straight-down in the nonstrabismus patient. The patients were seen for reasons other than an eye muscle examination. Against this background of more or less normal values, it was felt that the meaning of the A and V syndromes† would stand out more clearly.

METHOD OF STUDY

The study covered a series of 100 cases. All patients were under 38 years of age and, for the most part, were seen for routine refraction. No case in which there was any form of eye disease was included. The eyes were refracted and the fusion tested. Cover measurements for distance and near, as well as measurements in the middle vertical meridian, were made, all without correction.

In measuring in the vertical meridian, two methods were used for the purpose of comparison because of Adler's[5] statement that altering the position of the head introduces reflexes from such sources as the neck. All patients in the series were measured with the head tilted up and then with it tilted down. In addition, 30 of these patients were measured with the head held horizontally.

RESULTS

Incidence of deviation in eyes-up or eyes-down position. In 62 percent of cases, some deviation (exophoria except in two cases) was apparent either in the eyes-up or eyes-down position, or in both. In one case the deviation was as much as 22 prism diopters (fig. 1).

Incidence of A, V and H‡ phoria. A, V and H esophoria will not be discussed here except to state that the incidence was low (two percent). A exophoria was observed in 14 percent of cases, and V exophoria in 40 percent. In six percent of cases, deviation in the eyes-up position equalled that in the eyes down ("H" exophoria). In the remaining 38 percent, no deviation was found either in the eyes-up or eyes-down position (fig. 2).

Measurements with the head held in the horizontal plane compared with those in which the head was tilted up and down. Measurements in the 30 cases in which the head was held horizontally were compared with those in which the head was tilted up and then down. In 13 (43.3 percent), no difference in measurements was shown, and in six of the 13 there was no deviation in any direction.

In the remaining 17 cases (56.6 percent), differences were noted on comparing results of the two methods. In 16 of these, there was a difference of five prism diopters or less, and in one a difference of eight prism diopters (fig. 3).

From the foregoing, it would appear that the ideal method of measuring is with the patient's head held in the horizontal plane. If, however, measuring with the head held horizontally becomes almost an impossibility, as may occur with small children, the difference probably would not be great.

Findings in extreme gaze in eyes up and

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† Using Friedenwald's[4] terminology, the situation might be referred to as anisophoria (or anisotropia) in the vertical meridian, more specifically the middle vertical meridian.

‡ For convenience, the term, "H" deviation, was adopted to indicate the type of deviation present when that in the eyes-up position equalled that in the eyes-down. For example, in one case there was no deviation in the primary position for distance or near but in both the eyes-up and eyes-down positions there was exophoria of eight prism diopters.

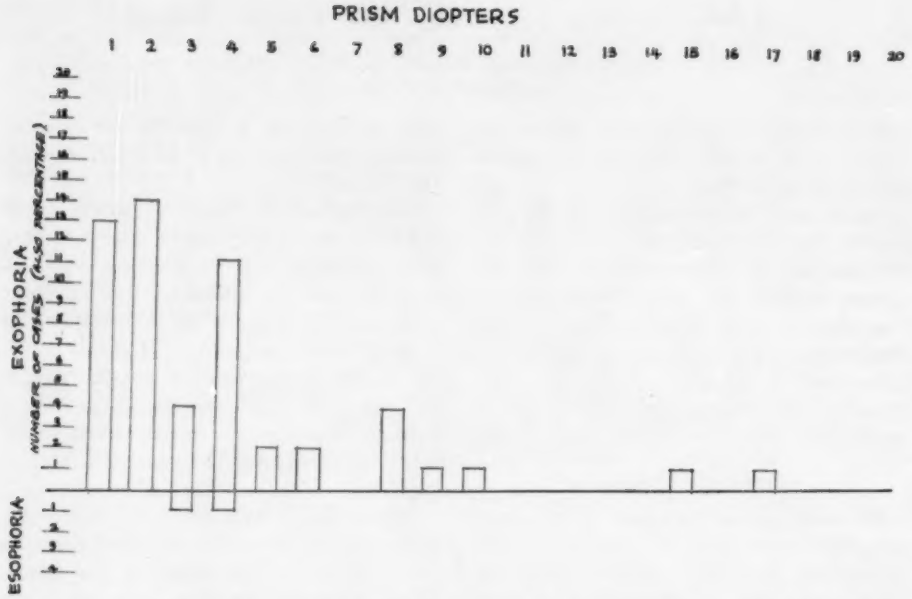

Fig. 1 (Magee). Prism diopters difference in horizontal phoria between eyes up and eyes down.

eyes down. After completing measurements in the eyes-up and eyes-down positions, 91 patients were observed in extreme gaze up and down. In other words, these patients were instructed to move the eyes upward, as well as downward, as far as possible. Four of the 91 exhibited only nystagmus in extreme gaze. Sixty-one (67 percent) showed no gross deviation. Of the latter group, 33 were A, V, or H exophoria deviation types. (In addition, one patient showed V esophoria; another, A esophoria.) Twenty-six (28 percent) of the 91 showed obvious exotropia, either in eyes up or eyes down, or in both. Of the 26, 17 were A, V or H exophoria deviation types (fig. 4).

Measurements for distance and near in the eyes-straight position. What were the horizontal deviations in the eyes straight position with the varied occurrence of A, V and H deviation?

In 40 of the 100 cases studied, no deviation was found in the horizontal meridian in the eyes straight-ahead position, nor was any A, V or H phoria observed. In 31 cases, no horizontal deviation in the primary position was noted, but there was found some A, V or H deviation. In two cases, there was horizontal deviation in the primary position without vertical anisophoria. The horizontal deviation in these two instances was esophoria, greater for near.

There remains, then, a total of 27 cases of A, V or H deviation in which there was shown a horizontal primary position deviation. In three of these there was esophoria (two greater for near, one equal for distance and near). In one of the three cases, the patient showed A esophoria, and in the remaining two V exophoria was found.

The other 24 cases of exophoria in the eyes-straight position were divided thus: 16, V exophoria; six, A exophoria; two, H exophoria. In all 24 instances, the exophoria deviation was greater for near than for distance.

With anisophoria in the middle vertical meridian in the absence of horizontal devia-

tion for distance or near, what was its distribution? Of the 31 cases so found, there were 23 in which V exophoria was shown, with A exophoria in seven cases, and V esophoria in one (fig. 5).

The refractive error did not show any relation to A, V, or H deviation. In all cases there was excellent third-degree fusion.

Comment

Although the amount of A or V exophoria was not necessarily great, the deviation in the eyes-up and eyes-down positions often was sizable. Thus, in one case there was V exophoria of one prism diopter, but the deviations were $X' = 9$ in eyes up and $X' = 8$ in eyes down. Similarly, in another case there was V exophoria of eight prism diopters and the deviations were $X' = 20$ in eyes up, and $X' = 12$ in eyes down.

It would seem of consequence not to have the patient merely gaze in extreme. Of the 91 patients observed, nine showed obvious deviation in extreme gaze but none when fixing a light.

In studying the eyes-straight position when there was A, V, or H deviation, no pattern could be discerned. To illustrate, although V exophoria cases were in preponderance among the number showing exophoria greater for near, there was, at the same time, a sizable number of A exophoria deviations. In similar fashion, when there was A, V or H deviation without horizontal deviation in the primary position, V exophoria cases were predominant but, again, there was a significant number in which A exophoria was shown.

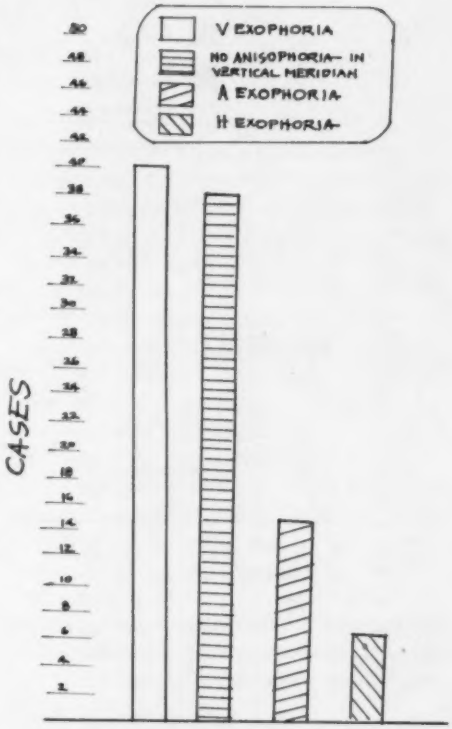

Fig. 2 (Magee). Incidence of A, V, or H exophoria.

In the entire series, there was but one case of vertical deviation: right hyperphoria of one prism diopter, for distance and near. It would appear, therefore, that there can exist sizable deviations (22 prism diopters

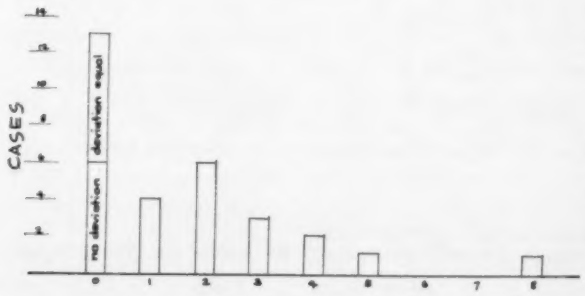

Fig. 3 (Magee). Prism diopter difference in same patient. Comparison with head tilted and held horizontally.

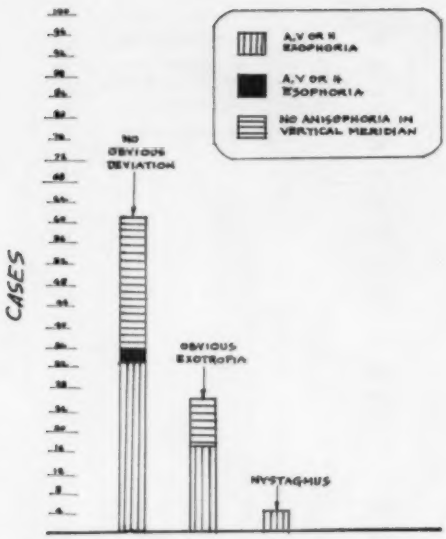

Fig. 4 (Magee). Findings in extreme gaze in vertical meridian.

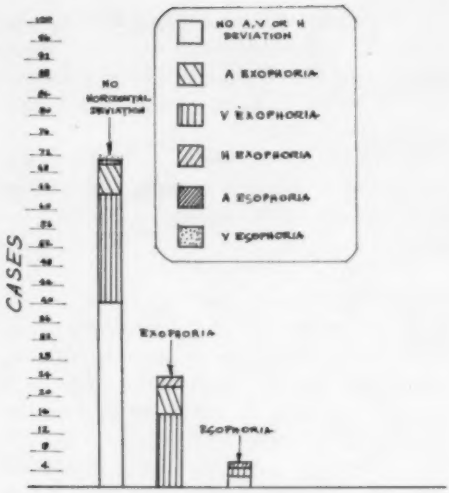

Fig. 5 (Magee). Horizontal deviation in eyes-straight position.

the largest) in the eyes-up or eyes-down position without vertical deviation in the eyes-straight position.

Conclusions

1. The incidence of anisophoria in the middle vertical meridian (A, V, or H deviation) is common in the nonstrabismus patient.

2. The ideal method for measuring the eyes is with the patient's head held in the horizontal plane.

3. In measuring for A, V, or H deviation, it is well to have the patient fix a light rather than gaze in extreme.

4. As an arbitrary minimal figure, a difference of 20 prism diopters between the eyes-up and eyes-down positions is suggested for V exophoria, since the greatest difference encountered in the series of 100 cases was 17 prism diopters.[6] For A exophoria, a difference of five prism diopters suggests itself as an arbitrary minimum, since a variation of four prism diopters was the greatest observed. No statement is made regarding A or V esophoria because of the low (two percent) incidence.

5. These data do not offer positive information concerning the cause of anisophoria in the vertical meridian in the nonstrabismus patient. In cases of this type, neither vertical deviation nor overaction or underaction of certain horizontal muscles seems to play a part.

805 Atlas Building (1).

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EFFECTIVE MANAGEMENT OF STRABISMUS*

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The entire field of ocular motility and imbalance is extremely complex and is often bewildering both to the neophyte and seasoned practitioner. In any complex field where progress is being made, conflicting ideas and reports must appear before final truths can be arrived at. Some authors are extremely enthusiastic about the value of orthoptics, while others seem to question its ultimate value in all but a few limited situations. The treatment of anomalous correspondence, for example, continues to be a controversial subject. Basic research articles concerned with the sensory aspects of strabismus and electromyography seem to indicate that we may be dealing primarily with a disturbance in neurophysiology and psychology of vision and therefore a physiologic and psychologic approach rather than an anatomic one might be preferential. The active surgeon on the other hand can usually cite many cases of improved physiology of vision following corrective surgery. During the past few years a great deal has been written on the A-V syndrome and special emphasis has been placed on such sensory aspects of strabismus as retinal disparity, the blindspot syndrome, anomalous correspondence, harmonious and unharmonious, and most recently on the theory and practice of pleoptics. The development of electromyography has emerged as an outstanding contribution.

All of these articles, which are at times difficult to understand and at other times conflicting, are of value and only reflect the fact that we are dealing with a very complex neurophysiologic, anatomic, and psychologic problem. They should be read and understood by the conscientious ophthalmologist but should not so confuse him that he loses sight of the basic goals of strabismus management and the simple methods now available to produce efficient, satisfying results.

The purpose of this article is to point out what I believe from personal experience to be the most practical and effective approach to the common and universal problem of strabismus. There is no intention on my part to detract from or to minimize the importance of electromyography, pleoptics, and other research aspects of ocular imbalance. Specifically this paper is designed to encourage the ophthalmologist practicing away from the large centers to adopt a more active approach in handling the large number of strabismus problems that come under his care. The ophthalmologist in these circumstances must come to realize that, because of environmental limitations, there is no substitute for early, well-planned and well-executed surgery.

To manage strabismus effectively in outlying areas the ophthalmologist must accept as a basic premise the fact that he is dealing primarily with a surgical rather than a medical problem, unless there are definite indications to the contrary. With this orientation, the utilization of glasses, occlusion and/or orthoptics properly falls into the category of pre- and postoperative management. The dramatic improvement in a patient's appearance after surgery usually seems to encourage prolonged follow-up visits so that amblyopia can be controlled and necessary adjustments in the strength of glasses can be utilized to help maintain good alignment.

If, on the other hand, strabismus is considered to be primarily a medical problem and a conservative approach is adopted, the usual result is patient dissatisfaction and discouragement and failure to return for further follow-up visits. The end-result often

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is deep, permanent amblyopia, residual deviation, and psychic scarring. The latter triad is all too frequently seen and by itself is a strong argument for a more active approach.

The concept that strabismus is a medical or neurophysiologic problem should be adopted by those engaged in basic research, with the hope that in the future surgery for strabismus will become outmoded. At the present time, however, this conservative approach offers the patient too little and should not be adopted by the practicing ophthalmologist.

The following facts are important and must be considered by each clinician before he can formulate his own policy on the management of strabismus.

1. Almost two out of every 100 children have some type of a motility problem and these problems have a universal distribution.

2. The services of an orthoptic technician are usually not available in outlying areas because of their limited number and their concentration in the larger medical centers.

3. Because of lack of transportation and other socio-economic reasons the majority of children from outlying areas will not have an opportunity to be treated at our large medical centers where the services of technicians are available and must remain and be treated in their home towns.

4. The responsibility for the manageemnt of a large segment of the population of strabismic children therefore falls on the shoulders of the local ophthalmologist who is usually burdened with an excessive patient load and has little or no time available to practice office orthoptics to any great degree.

For the above reasons it is logical to conclude that a practical approach has to be developed to deal effectively with the large volume of motility problems that require attention. In my own experience I have been able to evolve what I believe to be an efficient and satisfying approach to the motility problem by considering two fundamental questions.

1. What does the patient or his parents really want?

2. What is the individual patient's potential and what is the quickest and most effective way of accomplishing this?

The parents obviously want their child's eyes to be straight. They are usually completely unaware of suppression, amblyopia, and other complications of strabismus. The ophthalmologist would also like to have the eyes straight but in addition is anxious to realize the maximum functional potential of each individual. This may be fusion with amplitude, alternating equal vision or simply cosmetic improvement. In addition I believe that the alert ophthalmologist should be aware of the psychic scars produced by the stigma of strabismus and he should help to alleviate his patient of this aspect of the problem even though a functional result may not be possible.

With the above goals in mind I have adhered to the following principles in managing strabismus cases:

1. Analysis of the type, comitance and magnitude of the deviation, utilizing prism measurement in the prime and cardinal positions.

2. Atropine refraction and utilization of hyperopic corrective lenses for the control of any accommodative element that may be present. Bifocals are used when the accommodation-convergence ratio is disproportionate, resulting in excessive esodeviation at near range not corrected by a monocular lens.

3. Total occlusion to restore 20/20 vision and free alternation when possible. This also serves as a passive form of treatment for anomalous retinal correspondence, if present, by preventing reinforcement of the anomalous association.

4. Evaluation of the fusion potential on the Troposcope when amblyopia has been eliminated. No effort is made to treat anoma-

lous correspondence or to eliminate suppression preoperatively, as I find this to be impractical. In addition valuable time may be lost and the patient and parents often become discouraged.

5. Well-planned early symmetrical surgery within physiologic limits for residual deviations to make the patient cosmetically presentable, to prevent or breakup anomalous correspondence, and to enable those with normal correspondence and good fusion potential to overcome their deviation with a minimum of effort.

6. Simple postoperative home orthoptic exercises in the few instances where applicable and parental and child co-operation are good.

I do not believe that much is gained by prolonged observation. Once it has become apparent that residual, noticeable deviation exists, the physician should proceed with corrective surgery without delay, since this is what the patient really wants. It may spare the child from psychic trauma in addition to offering definite therapeutic advantages to children under three years of age.

In many cases the ultimate goals of treatment can be defined within a short period of time and after only a few visits to determine the variability or stability of the strabismus. In some instances the entire preoperative workup and observation period may require only a few weeks before surgery. In questionable or variable cases prolonged observation is needed. In my private practice the majority of cases with a stable and noticeable residual deviation after corrective lenses and occlusion undergo surgery at an early date. Surgery is fast and effective; usually there will be no overcorrection if a careful analysis has been carried out and the principles laid down by many authorities in this field are adhered to. The level of patient satisfaction following surgery is very high and compares favorably with the most rewarding experiences in medicine.

Statistics

During the four years ending November, 1959, I have operated on 300 muscles at 159 operations on 143 private patients. The surgery was performed at the local community hospital. There were 92 operations for esotropia; 10 of these were complicated by a vertical component of sufficient magnitude to require surgery. There were 54 operations for exotropia; four of these were complicated by a vertical muscle imbalance large enough to require surgery. There were 13 operations for hypertropia alone. There were 79 bilateral symmetrical operations, 17 bilateral asymmetrical procedures, and 63 monocular operations.

The number of muscles operated per operation were: 40 cases with one muscle only, 94 cases with two muscles, 18 cases with three muscles, and two cases with four muscles.

Of the total of 143 patients, 17 had to undergo a second operation: four for overcorrection, seven for undercorrection; six for correction of a residual vertical deviation. There were nine overcorrections. Of the four which required corrective surgery, three were for overcorrected esotropia and one for an overcorrected exotropia. The remaining five cases may come to surgery later but at present the overcorrection is minimal.

Of the 300 individual muscles operated on the medial rectus was approached most commonly with a total of 155 procedures. There were 113 operations on the lateral rectus, one on the superior rectus, one on the inferior rectus, 28 on the inferior oblique, and two on the superior oblique. Of the 143 patients, 15 were one year and 19 were two years of age, making a total of 34 patients under three years of age.

More detailed information can be gathered from Tables 1 through 5.

Discussion

Because of the multiplicity of variables in an analysis of this type (age of onset, dura-

TABLE 1

GENERAL STATISTICS AND INCIDENCE OF PROCEDURE IN EACH DIAGNOSTIC CATEGORY

Total No. of patients operated	143
Total operations	159
Total No. of muscles operated on	300
Total patients operated twice	17
Total overcorrections	9
Overcorrections re-operated	4
ESOTROPIA	
1. Bilateral recession medial recti	38
2. Recession medial rectus	25
3. Bilateral recession medial rectus and resection lateral rectus	10
4. Recession medial rectus and resection lateral rectus	7
5. Bilateral resection lateral recti	2
Total	82
ESOTROPIA WITH HYPERTROPIA	
1. Bilateral recession medial recti and recession inferior oblique	3
2. Recession medial rectus and recession inferior oblique	2
3. Resection lateral rectus and recession inferior oblique	2
4. Recession medial rectus, resection lateral rectus, recession inferior oblique	2
5. Bilateral recession medial rectus, resection lateral recti, recession inferior oblique	1
Total	10
EXOTROPIA	
1. Bilateral recession lateral recti	34
2. Recession lateral rectus	3
3. Bilateral recession lateral recti and resection medial rectus	2
4. Bilateral medial recti resection	1
5. Resection medial rectus	2
6. Recession lateral rectus and resection medial rectus	7
7. Advancement medial rectus	1
Total	50
EXOTROPIA WITH HYPERTROPIA	
1. Bilateral recession lateral recti and recession left superior rectus	1
2. Recession right lateral rectus and recession left superior rectus	1
3. Recession right lateral rectus and recession right inferior rectus	1
4. Recession right lateral rectus, resection right medial rectus, tenotomy right superior oblique and tenotomy right inferior oblique	1
Total	4
HYPERTROPIA	
1. Recession inferior oblique	8
2. Bilateral recession inferior obliques	4
3. Left superior oblique tuck	1
Total	13

tion of time between onset and treatment, inconsistencies in parental ability to follow orders, duration of follow-up, and so forth), it is impossible to discuss results except in generalities. By and large a result may be considered good if the estimated maximum potential can be achieved in each case whether this potential be fusion with amplitude or alternating vision or simply cosmetic improvement. The following observations seem significant:

1. In general, the preoperative estimate of the ultimate goal was usually achieved in this series, although occasionally I found that a child would resume fusion when I believed this to be impossible. In appraising the functional result I have been more and more impressed with the manner in which a patient performs in his every-day environment than with his performance during artificial tests on the Troposcope. When a tropia has been corrected to a phoria through surgery, as demonstrated by the simple cover test, and when the child is able to place a pencil point quickly against one the examiner holds in a vertical position, then the result is a good functional one regardless of the fact that some residual suppression may be demonstrated on the Troposcope.

It has been gratifying to see a fair number of children, operated on at the age of one and two years, able to perform these simple fusion tests several years later. If they had not had surgery early in life, I believe it would have been impossible for them to achieve this regardless of how much treatment they received later on. This applies particularly to children with congenital esotropia, or esotropia of very early onset. In addition, early surgery for intermittent exotropia is also beneficial for it tends to stabilize the eyes, enabling the fusion reflexes to become more firmly established.

2. The patients and parents were usually highly satisfied with the results of surgery. The psychologic aspects of strabismus are not sufficiently emphasized and in this regard age is no barrier. Some of my most grateful

TABLE 2

TYPE AND FREQUENCY OF OPERATIVE PROCEDURES UTILIZED ON VARIOUS MUSCLES

MEDIAL RECTUS	
Recessions	140
Resections	14
Advancement	1
Total	155
LATERAL RECTUS	
Recessions	87
Resections	26
Total	113
SUPERIOR RECTUS	
Recession	1
Resection	0
Total	1
INFERIOR RECTUS	
Recession	1
Resection	0
Total	1
INFERIOR OBLIQUE	
Recession	27
Tenotomy	1
Total	28
SUPERIOR OBLIQUE	
Tuck	1
Tenotomy	1
Total	2
GRAND TOTAL	300

patients have been business men and women in their forties who have always felt inferior because of their handicap.

3. Very few overcorrections developed; however, the follow-up period has not been long and some cases may occur in addition to the nine reported.

In the actual performance of the surgery I believe in the following principals:

1. The surgeon should be able to operate on any of the 12 muscles when indicated and not just the horizontals.

2. Bilateral symmetrical surgery should

TABLE 3

NUMBER OF MUSCLES OPERATED PER OPERATION

One muscle	40
Two muscles	94
Three muscles	18
Four muscles	2

TABLE 4

FREQUENCY OF MONOCULAR AND BILATERAL SYMMETRICAL AND BILATERAL ASYMMETRICAL PROCEDURES

1. MONOCULAR OPERATIONS	
One muscle	40
Two muscles	20
Three muscles	2
Four muscles	1
Total	63
2. BILATERAL SYMMETRICAL SURGERY	79
3. BILATERAL ASYMMETRICAL SURGERY	17

be carried out wherever possible and within physiologic limits to avoid overcorrection. Cushman's tables on this are excellent and have worked out well in my hands. The medial recti should not be recessed over 4.0 mm. and preferably no more than 3.0 to 3.5 mm. In children under three years of age a medial rectus recession should not exceed 3.0 mm.

3. I try to avoid doing more than two horizontal muscles at one sitting, as this often results in overcorrection unless the degree of turn is of large magnitude. Two horizontals and one or two verticals can be done at one operation.

4. In congenital esotropia or esotropia of early onset I prefer to operate very early (six months to one and one-half years). I believe this offers the only hope for development of fusion. If the eyes are not straight during the first three years of life, fusion will, theoretically, never develop. Usually my initial procedure in these cases is a bilateral 3.0 mm. recession of the medial recti. Some of the children who were operated on under two years of age can now definitely fuse.

TABLE 5

INDICATIONS FOR SECOND OPERATION

Esotropia undercorrected	3
Exotropia undercorrected	3
Residual hypertropia after surgery for esotropia	5
Residual hypertropia after surgery for exotropia	1
Hypertropia undercorrected	1
Esotropia overcorrected	3
Exotropia overcorrected	1
Total	17

5. With intermittent esotropia or residual esotropia with fusion potential, the planned surgery should take up the nonaccommodative portions. This allows the child to strengthen fusion reflexes by enabling him to hold his eyes straight with less effort. Thus he can maintain alignment for greater periods each day.

6. When surgery for esotropia is purely cosmetic, it is wise to undercorrect to avoid consecutive divergence. Usually I try to reduce the degree of esotropia to between 10 and 20 prism diopters. If one eye is amblyopic and cannot be restored with occlusion, monocular surgery is carried out in order to avoid operating on the good eye. At times, monocular procedures are also employed in noncomitant strabismus.

7. With intermittent exotropia, an early bilateral recession of the external recti is used. This usually has to be at least seven mm. on each side or an undercorrection will result. Recessions of less than five mm. even in mild exodeviations are usually ineffective. I prefer this to a bimedial resection even though the error may measure more for near and the convergence may be poor. Often the near-point of convergence will improve greatly after a bilateral recession of the laterals and, if this is not sufficient, the medials can always be resected later.

8. The same approach is followed for alternating and monocular exotropia. The recession of the laterals must be fairly generous and can often be as much as nine mm. In dealing with all forms of exotropia it has been my experience that spontaneous improvement does not occur and that progression to larger deviations, often from the intermittent to alternating type, occurs. With the passage of time, the ease of exodeviation increases as the lateral muscles become stronger and overbalance more easily the declining medials. The fusion reflex, which is the only opposing force, becomes weaker as the hemiretinal suppression deepens with the amount of time spent in the exotropic position. Unless interrupted, the vicious circle may increase the degree of exotropia, resulting in exodeviation too great to overcome and in deep suppression with loss of fusion (alternating or monocular exotropia). The near-point of convergence may become more and more remote until all convergence power is lost.

Early surgery breaks up the progressive train of events by weakening the laterals, allowing the medials to become more effective, as witnessed by a greater near-point of convergence and, most important, allows the fusion reflex to regain tone as the hemiretinal suppression regresses. It is my opinion that the pathologic physiology with resultant secondary changes can be held in check by early adequate surgery in cases of intermittent exotropia. Although it is difficult to overcorrect an exotropia, it does happen from time to time, as shown by several cases in this series. Many of the good surgical results, however, go through an initial period of overcorrection lasting several weeks. This should not alarm the surgeon. The slightly overcorrected position may be helpful in partly eliminating the hemiretinal suppression in the lateral quadrants.

9. Vertical muscle surgery is often resorted to and on some occasions has resulted in a good functional result with fusion, or in the elimination of a headtilt or torticollis. In my experience, the inferior oblique seems to require recession most often but the vertical recti and superior obliques are operated on when the indications are present.

10. If overcorrection occurs, I believe it wise to operate on the secondarily contracted muscles or overactive yoke muscles rather than to reoperate on the original muscles. An overcorrected esotropia with consequent divergence usually does well with a bilateral recession of the external recti. An overcorrected exotropia will usually respond to a recession of one medial rectus. If there is obvious limitation of duction, particularly of adduction following a recession of a medial rectus, it is necessary to advance the medial rectus back to its original insertion,

with recession of the secondarily contracted direct antagonist or recession of the overactive synergistic yoke muscle in the opposite eye. If there is definite secondary contracture of the direct antagonist as evidenced by a preoperative forced duction test, I prefer to recess this muscle rather than the overactive yoke muscle.

I have mentioned very little about orthoptics because this paper concerns itself for the most part with gross strabismus and not with heterophorias. Other than occlusion, orthoptics is not used preoperatively, although occasionally a red glass will be used over the dominant eye to try to establish alternation when the vision becomes equal after occlusion. Preoperative orthoptics in my hands has proven to be impractical and ineffective and is seldom resorted to.

Early surgery seems to be the best way to prevent anomalous correspondence from developing or, if it has already developed, surgery will serve to alter the retinal relationships before the condition becomes too permanently established. Prolonged orthoptic treatment in these cases is often unsuccessful and the time lost lessens the therapeutic effect of surgery.

Orthoptic exercises of a simple nature are sometimes utilized postoperatively when the retinal correspondence is normal and the patient is able to fuse on the Troposcope. The wearing of a red glass to make the patient conscious of diplopia, tracing with a red filter over the dominant eye and physiologic diplopia exercises (bar reading, and so forth) are occasionally used to overcome suppression.

Acutally, the number of patients who might benefit by simple exercise to combat suppression is greatly reduced by lack of parental interest and intelligence. Ironically the children who cannot possibly be helped by orthoptics often have the parents who are most anxious and have the intelligence to supervise home orthoptic exercises. By and large in my practice the use of orthoptics to eliminate suppression and to improve fusion amplitude has been the exception rather than the rule because of the reasons enumerated; however, I do believe that orthoptics can be quite beneficial in properly selected cases.

Summary

The current literature on problems of motility is voluminous, frequently complicated, and often conflicting. This article was written in an effort to present a practical, effective approach to the complicated but universal and common problem of strabismus.

The overburdened ophthalmologist in an outlying area is often called upon to handle a large number of strabismus cases. In most instances the services of orthoptic technicians are not available to him. The importance of orthoptics in selected cases is not denied; however, it is often impractical for the busy ophthalmologist to participate actively in this form of treatment.

In arriving at an effective plan for the management of strabismus cases two important questions must be answered for each individual case: (1) What does the child or his parents really want? (2) What is the maximum potential of the individual case in question and what is the quickest and most efficient way of realizing this goal?

The patient's desire for straight eyes and the ophthalmologist's goal of realizing maximum potential (fusion with or without amplitude, alternation or cosmetic improvement) can usually be quickly satisfied by a careful diagnostic workup, utilization of hyperopic glasses, occlusion, and early corrective surgery. When properly timed, surgery is swift, effective, and dramatic and can often bring about a functional result. In outlying areas the ophthalmologist must adopt the realistic concept that strabismus is primarily a surgical problem rather than a medical problem, unless there are definite indications to the contrary.

To achieve maximum results the surgeon should be able to operate on any of the 12 muscles and be willing to proceed without

delay when there is clear-cut residual deviation.

If well-established general principles are adhered to the chances of overcorrection can be held to a minimum.

The basic diagnostic workup, preoperative treatment, and surgical principles to which I subscribe are outlined.

A method of handling overcorrections is suggested.

Statistics on 143 private cases operated during the past several years are presented.

In most instances the planned goals were achieved and the level of patient satisfaction was high.

The psychologic scars produced by strabismus strongly call for early elimination of the cosmetic blemish, even though a functional result may not be possible.

The surgeon who pursues an active program in the management of strabismus will soon develop a following of well-satisfied and grateful patients and, in addition, will achieve personal satisfaction from his work.

32 Grove Hill.

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DIVERGENCE EXCESS COMBINED WITH CONVERGENCE EXCESS IN THE V-SYNDROME*

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Alexander Duane[1] in his prize-winning thesis, "A new classification of motor anomalies of the eye," presented the concept that certain cases of horizontal squint could be produced by supranuclear innervational anomalies, namely, excess or insufficiency of either the divergence or the convergence mechanism. Many cases that fit into one of these four categories have been observed and have lent a good deal of weight to Duane's classification. However, Duane found that some cases did not fall into the clear-cut categories of divergence insufficiency or excess and convergence insufficiency or excess but were combinations of a convergence and divergence anomaly and often it was difficult to decide which was primary and which secondary.

In the analysis and practical management of such cases I have been greatly aided by the concept that (1) divergence is principally mediated through the lateral rectus muscles which have to do with distance and upward gaze, and (2) convergence is mediated principally through the medial rectus muscles which have to do with near and downward gaze.

According to this concept primary divergence excess manifests itself in overaction of the lateral rectus muscles, resulting in exotropia for distance and upward gaze with straight eyes for near and downward gaze. Primary convergence excess would manifest itself in overaction of the medial rectus muscles, resulting in esotropia for near and downward gaze with straight eyes for distance and upward gaze. Primary divergence excess with secondary convergence insufficiency would be tantamount to overaction of the lateral rectus muscles combined with underaction of the medial rectus muscles resulting in V-exotropia and finally, primary convergence excess with secondary divergence insufficiency would present the picture of overaction of the medial rectus muscles combined with underaction of the lateral rectus muscles, resulting in V-esotropia.

Duane's concept was that the combined anomalies were usually additive in that a primary deviation, present at first only in a certain position of gaze, extended, by means of a secondary anomaly, to all positions of gaze. In a paper,[2] "Simulated divergence paralysis," I presented a series of unusual A-syndrome cases that had an esotropia for distance and upward gaze, straight eyes for near and an exotropia on downward gaze. In these cases I interpreted the esotropia as being due to underaction of the lateral rectus muscles, primary divergence insufficiency, and the exotropia looking down as due to a compensatory underaction of the medial rectus muscles, secondary convergence insufficiency in order to keep the eyes straight for near. It was assumed that in these cases the combined anomalies, instead of being additive, were subtractive in that the secondary deviation was opposite in type to the primary in order to obtain or maintain straight eyes and fusion in some portion of the field of fixation.

In the following a series of cases of V-syndrome will be presented which, in my opinion, also lend themselves to the interpretation that combined anomalies, opposite in type, were operative and resulted in straight eyes in certain portions of the field of fixation.

CASE REPORTS

CASE 1 (3-213)

A six and one-half-year-old boy was brought to the Infirmary on November 11, 1950, with a his-

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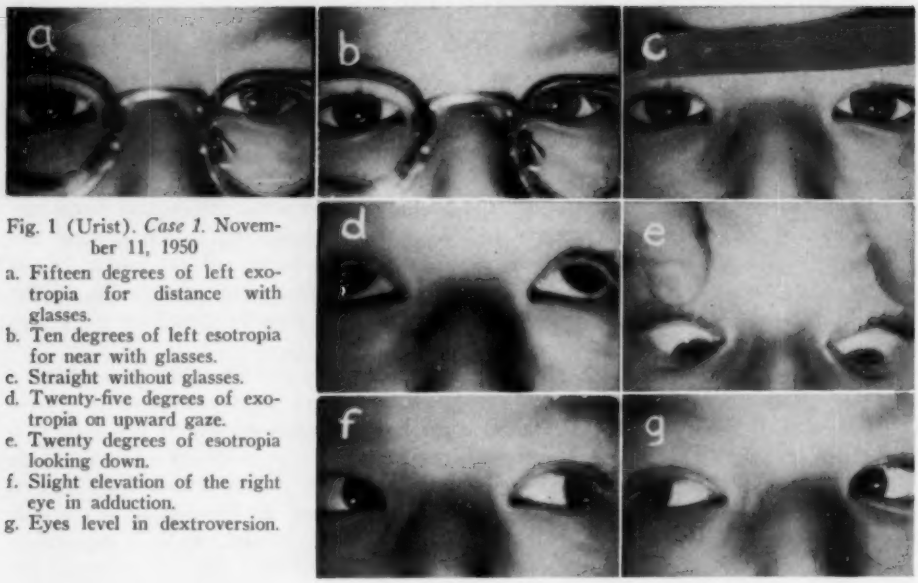

Fig. 1 (Urist). *Case 1.* November 11, 1950

a. Fifteen degrees of left exotropia for distance with glasses.
b. Ten degrees of left esotropia for near with glasses.
c. Straight without glasses.
d. Twenty-five degrees of exotropia on upward gaze.
e. Twenty degrees of esotropia looking down.
f. Slight elevation of the right eye in adduction.
g. Eyes level in dextroversion.

tory of holding things too close when reading. Refraction and vision under atropine cycloplegia were:

O.D., −0.5D. sph. ⊃ +4.0D. cyl. ax. 105° = 20/30
O.S., −0.25D. sph. ⊃ +4.0D. cyl. ax. 75° = 20/100

On examination (fig. 1) with and without glasses he had 15 degrees of exotropia for distance, 10 degrees of esotropia for near and at times straight eyes; there was 25 degrees of exotropia looking up, 20 degrees of esotropia looking down, elevation of the right eye in adduction with a right hypertropia straight ahead while on gaze to the right, there was no vertical deviation. The convergence nearpoint was 40 mm. Prism cover measurements were:

c/c ET 14Δ, RH 7Δ; ET′ 12Δ, RH 5Δ.
s/c ET 18Δ, RH 6Δ; ET′ 15Δ, RH 6Δ.

	XT 8	XT 10	XT 14 RH 8	
Right	ET 10	ET′ 15 RH 6	ET 16 RH 6	Left
	ET 12	ET 22	ET 25	

Following occlusion of the right eye vision in the left eye improved to 20/50. At the subsequent periodic examinations in the Motility Clinic esotropia was found most of the time; occasionally exotropia was noticed for distance while on looking up an exotropia was consistently observed. On July 1, 1958, the myopia had progressed to:

O.D., −2.75D. sph. ⊃ +3.5D. cyl. ax. 105° = 20/20
O.S., −2.0D. sph. ⊃ +4.0D. cyl. ax. 75° = 20/50

On July 31, 1958 (fig. 2) the eyes could be straight with and without glasses, they were 15 degrees divergent looking up and 15 degrees convergent looking down. Slight depression of the left eye in adduction was seen on dextroversion while the eyes appeared level on levoversion. Retinal correspondence was normal with fusion at 0. Prism cover measurements were:

c/c ET 8Δ, RH 5Δ; ET′ 6Δ, RH 5Δ.
s/c ET 8Δ, RH 5Δ; RH′ 5Δ.

	XT 14 LH 5	XT 15	XT 7 RH 6	
Right	ET 10	RH 5	ET 5 RH 4	Left
	ET 12	ET 10 RH 2	ET 12 RH 5	

Comment. The outstanding feature of this case was exotropia for distance and looking up and esotropia for near and looking down. With these marked deviations it was surprising that the eyes were parallel with normal sensory relationship in the central positions of gaze most of the time. It seems reasonable to assume that whenever and wherever the eyes were straight a balance occurred between a divergence excess and a convergence excess. The consistent exotropia on looking up with the confirmatory

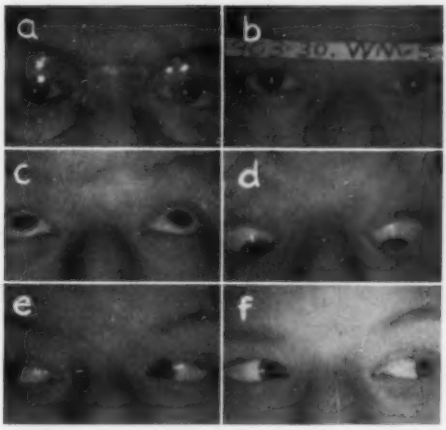

Fig. 2 (Urist). *Case 1.* July 31, 1958

a. Straight with glasses.
b. Straight without glasses.
c. Fifteen degrees of exotropia on upward gaze.
d. Fifteen degrees of right esotropia on downward gaze.
e. Slight depression of the left eye in adduction.
f. Eyes level in levoversion.

cover test measurements points toward divergence excess, possibly as the primary anomaly. The superimposed convergence excess, however, was the more prominent anomaly which was suggested by the fact that the large exotropia observed for distance during casual gaze or by the Hirschberg test, could not be confirmed by cover measurements in the primary position which were always those of esotropia. A logical interpretation of the findings seems to be that a convergence excess neutralized and made latent the exotropia under the conditions of straight-ahead gaze, and overcorrected it under the conditions of the additional stimulation of taking cover test measurements.

CASE 2 (271)

A five-year-old boy was brought to the Infirmary on March 14, 1946, with a history of the eyes turning in since the age of one year. Refraction and vision under atropine cycloplegia were:
O.D., +4.0D. sph. ⊃ +4.0D. cyl. ax. 105° = 20/30
O.S., +5.0D. sph. ⊃ +3.0D. cyl. ax. 85° = 20/30
After wearing the full atropine correction for three years he was referred to the Motility Clinic for further evaluation since esotropia was present with and without glasses. When examined on October 10, 1949 (fig. 3) the child was apprehensive but co-operative. He had 20 degrees of esotropia for distance and near with and without glasses. However, it was noticed that at times the eyes were straight looking up and down and appeared straight even without glasses. Prism cover measurements were:

c/c ET 5Δ; ET′ 25Δ.

There was fusion at 0 on the troposcope. A diagnosis of intermittent, variable esotropia was made and the patient was followed. After several visits to the clinic, he became acclimated and lost his initial apprehension, particularly after he had been told he would not need surgery. On November 25, 1950 (fig. 4) a different and probably truer picture of his condition became manifest. The eyes were straight with and without glasses, but at times, the following significant findings were present, namely: for distance, there was 25 degrees of exotropia with straight eyes looking up; for near and looking down there was 25 degrees of esotropia. Bilateral elevation in adduction was present. Prism cover measurements were:

c/c XT 18Δ, LH 3Δ; XT′ 30Δ, LH 1Δ.
s/c XT 17Δ, LH 4Δ; XT′ 20Δ, LH 2Δ.

	XT 40 LH 9	XT 37 LH 5	XT 30	
Right	XT 40 LH 2	XT′ 20	XT 30	Left
	XT 35	XT 35	XT 33	

The lenses were reduced to the following:

O.D., +4.0D. cyl. ax. 90° = 20/30 vision
O.S., +3.0D. cyl. ax. 75° = 20/30 vision

At the last examination on September 8, 1955 (fig. 5), the eyes were straight with glasses, 10 degrees convergent without glasses, straight looking up and down and level on lateral gaze. Prism cover measurements were:

s/c X 6Δ; X′ 6Δ.

	X 7 LH 2	X 10	X 9	
Right	X 6	X 6	X 9	Left
	X 9	X 8	X 12	

Comment: When first seen in the clinic the child was excited and nervous because he expected to submit to an operation. The diagnosis at that time was intermittent esotropia of the convergence excess type. This was confirmed by the cover measurements for distance and near. The possibility of a latent divergence excess was not entertained at that time. The patient's ability to

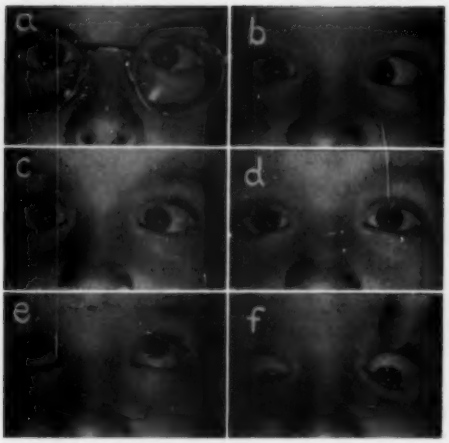

Fig. 3 (Urist). *Case 2.* December 19, 1949

a. Fifteen degrees of left esotropia for distance with glasses.
b. Thirty degrees of left esotropia for near without glasses.
c. Twenty degrees of left esotropia without glasses for distance.
d. Straight for distance without glasses.
e. Straight on upward gaze.
f. Straight on downward gaze.

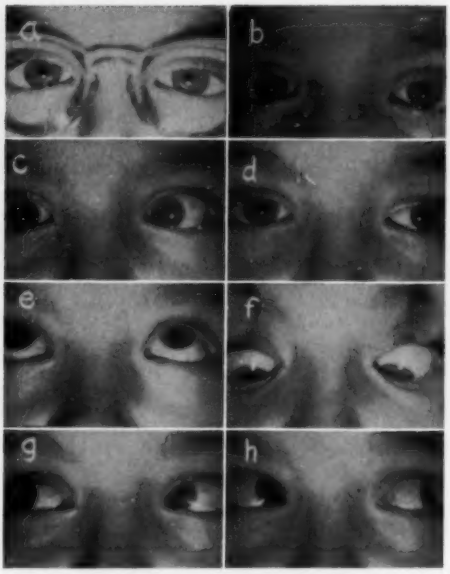

Fig. 4 (Urist). *Case 2.* November 25, 1950

a. Straight with glasses.
b. Straight without glasses.
c. Twenty-five degrees of left esotropia for near.
d. Twenty-five degrees of left exotropia for distance.
e. Straight looking up.
f. Twenty-five degrees of left esotropia looking down.
g. and h. Bilateral elevation in adduction.

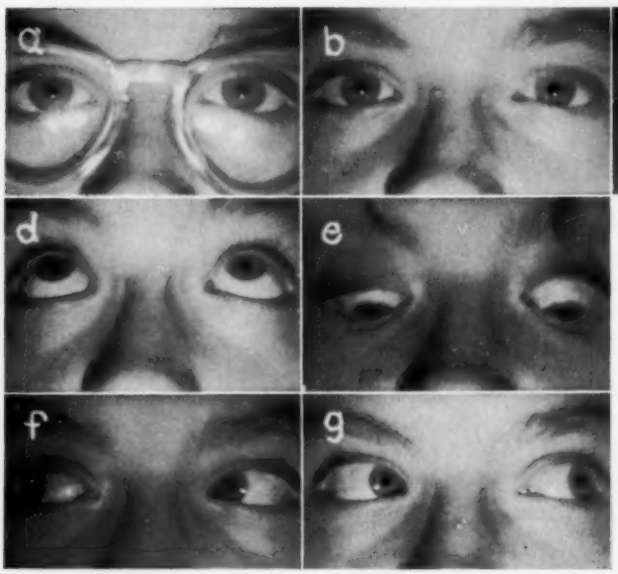

Fig. 5 (Urist). *Case 2.* September 8, 1955

a. Straight with glasses.
b. Ten degrees of left esotropia for near.
c. Convergence nearpoint 40 mm.
d. Straight on upward gaze.
e. Straight on downward gaze.
f. and g. Eyes level in lateral gaze.

straighten his eyes for distance and upward gaze from 30 degrees of esotropia could be interpreted as a sign of an excessive divergence innervation balancing a convergence innervation. This was confirmed when, with the loss of apprehensiveness, the convergence excess relaxed to some extent and a previously masked exotropia of 25 degrees became manifest at times. In contrast to Case 1, divergence excess was the dominant anomaly in Case 2 because, in 1955, even in the presence of a definite esotropia without glasses, exophoria was found by cover measurements in all positions.

CASE 3 (4.64)

An 11-year-old girl was brought to the Infirmary in January, 1953, with a history of the left eye turning in to the nose since nine months of age.

Refraction and vision under atropine cycloplegia were:

O.D., +0.25D. sph. ⊃ +1.25D. cyl. ax. 65° = 20/20
O.S., +1.5D. sph. = 20/20

Examination (fig. 6) revealed 10 degrees of exotropia for distance and upward gaze (divergence excess) and 10 degrees of esotropia for near and downward gaze (convergence excess). Most of the time, however, in the central intermediate position, the eyes were straight. There was elevation of the left eye in adduction while the eyes were level on gaze to the left. The convergence near-point was 30 mm. Prism cover measurements were:

c/c XT 12Δ, LH 10Δ; ET′ 5Δ, LH 9Δ.
s/c XT 11Δ, LH 10Δ; ET′ 18Δ, LH 9Δ.

	XT 9 LH 18	XT 18 LH 10	XT 5 LH 4	
Right	ET 20 LH 14	ET′ 18 LH 9	ET 23 LH 6	Left
	ET 44 LH 12	ET 48 LH 9	ET 46 LH 5	

Since the eyes were straight a good deal of the time and since exotropia was present for distance and esotropia for near, it was difficult to decide what surgery to do. Operation for the vertical deviation was deemed safe, and, on July 23, 1953, a 10 mm. tuck of the left superior oblique muscle was done. This corrected the large left hypertropia but uncovered a latent right hypertropia.

At subsequent periodic examinations in the Motility Clinic it was found that the exotropia tended to increase while the esotropia diminished. On November 7, 1956 (fig. 7) she had 15 degrees of exotropia for distance, 25 degrees looking up, straight eyes for near, 10 degrees of esotropia looking down, and slight bilateral elevation in adduction.

Fig. 6 (Urist). *Case 3.* January 10, 1953

a. Ten degrees of left exotropia with glasses for distance.
b. Ten degrees of right esotropia for near with glasses.
c. Straight in the intermediate position.
d. Ten degrees of exotropia looking up.
e. Twenty degrees of esotropia looking down.
f. Level in levoversion.
g. Elevation of the left eye in adduction.

Second grade fusion was found at 42 prism diopters base-in. Prism cover measurements were:

XT 25Δ; X′ 7Δ, LH 1Δ.

	XT 24 LH 5	XT 24	XT 12 RH 6	
Right	XT 4 LH 4	X′ 7	0	Left
	ET 10 LH 2	ET 8	ET 8	

To stimulate accommodative convergence —2.0D. sph. lenses were ordered for constant use.

At the last examination on February 27, 1958 (fig. 8) she had 10 degrees of esotropia with and without glasses for near and 5.0 degrees of exotropia with and without glasses for distance. Prism cover measurements were:

c/c ET 14Δ, LH 2Δ; ET′ 20Δ, LH 2Δ.
s/c XT 8Δ; ET′ 20Δ, LH 2Δ.

Second grade fusion was present at 6Δ base-out.

Comment. In this case of V-syndrome,

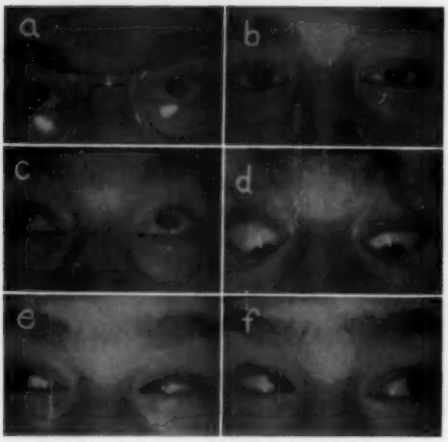

Fig. 7 (Urist). *Case 3.* November 8, 1956
a. Fifteen degrees of exotropia for distance.
b. Straight for near.
c. Twenty-five degrees of right exotropia looking up.
d. Ten degrees of right esotropia looking down.
e. and f. Bilateral elevation in aduction, increased in levoversion.

the divergence excess, exotropia for distance and upward gaze, balanced the convergence excess, esotropia for near and looking down, resulting in straight eyes in the central intermediate position between six m. and 25 cm. The presence of the large left hypertropia may have been a dissociating factor although when it was corrected there was no apparent change in the horizontal deviation, and a latent right hypertropia was uncovered. From the history it would appear that the esotropia had been the more prominent deviation. The excess convergence in early childhood may have made the divergenc excess latent until, with advancing age and growth changes, convergence became muted and then the underlying divergence excess became manifest. It was interesting that with the forced increase of accommodative convergence, by wearing minus lenses, the exotropia again became masked in that the cover measurements were esotropia. This again demonstrated how excess convergence disguised an underlying divergence.

CASE 4 (1-262)

An eight-year-old girl was brought to the Infirmary on January 27, 1950, with a history of crossed eyes since two years of age.

Refraction and vision under atropine cycloplegia were:

O.D., +6.0D. sph. ⊃ +2.0D. cyl. ax. 130° = 20/30
O.S., +7.0D. sph. = 20/30

There were 25 degrees of esotropia for near and 15 degrees for distance both with and without glasses but at times the eyes could be straight for distance with and without glasses (fig. 9). Looking up the eyes were straight, looking down, 15 degrees convergent and in adduction bilateral elevation was present. Prism cover measurements were:

c/c ET 20Δ, LH 14Δ; ET′ 30Δ, LH 14Δ.
s/c ET 20Δ, LH 14Δ; ET′ 30Δ, LH 14Δ.

	ET 16 LH 30		ET 18 LH 4	
Right	ET 18 LH 25	ET′ 30 LH 18	ET 18 LH 9	Left
	ET 18 LH 16		ET 20 LH 5	

To correct the conspicuous esotropia and left hypertropia, on May 8, 1950, an eight-mm. recession of the left inferior oblique muscle and an eight-mm. resection of the left lateral rectus mus-

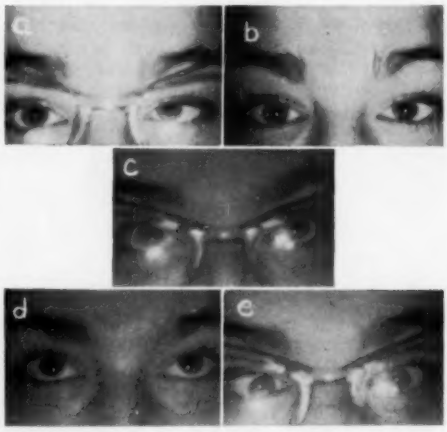

Fig. 8 (Urist). *Case 3.* February 17, 1958
a. Ten degrees of left esotropia for near with glasses.
b. Five degrees of left esotropia for near without glasses.
c. Five degrees of left exotropia for distance with glasses.
d. Five degrees of left exotropia looking up.
e. Fifteen degrees of right esotropia looking down with glasses.

cle were done. On August 10, 1950 (fig. 10), four months after surgery, for distance there was 20 degrees of exotropia with glasses and 10 degrees without. For near, with glasses, the eyes were straight and without glasses, 20 degrees convergent. A right hypertropia and elevation of the right eye in adduction was now observed. On dextroversion the eyes were level. Prism cover measurements were:

c/c ET 6Δ, RH 10Δ; E′ 3Δ, RH 14Δ.
s/c ET 7Δ, RH 8Δ; E′ 4Δ, RH 10Δ.

	XT 10 RH 2	XT 10 RH 8	XT 15 RH 25	
Right	ET 7 RH 2	E′ 4 RH 10	ET 3 RH 10	Left
	ET 14	ET 14	ET 10 RH 2	

The patient was still wearing the high plus correction when she returned to the clinic on June 20, 1956. At this time she had 25 degrees of exotropia

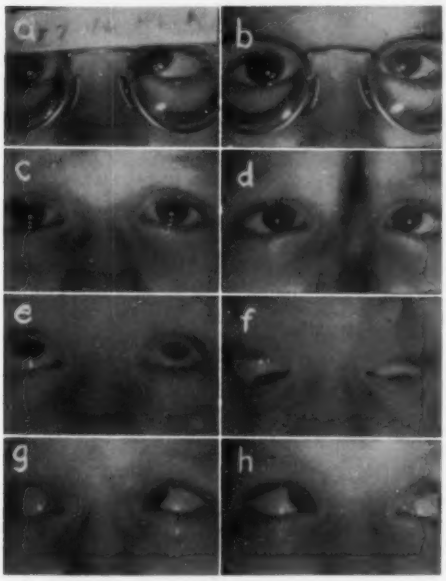

Fig. 9 (Urist). *Case 4.* January 20, 1950

a. Twenty-five degrees of left esotropia and 10 degrees of left hypertropia for near with glasses.
b. Fifteen degrees of left esotropia and five degrees of left hypertropia for distance with glasses.
c. Straight. Note the hypertropia has disappeared.
d. Convergence nearpoint is 30 mm.
e. Straight looking up.
f. Fifteen degrees of right esotropia looking down.
g. and h. Bilateral elevation in adduction.

Fig. 10 (Urist) *Case 4.* August 10, 1950

a. Ten degrees of right exotropia and five degrees of right hypertropia for distance without glasses.
b. Twenty degrees of right exotropia for distance with glasses.
c. Twenty degrees of esotropia and five degrees of right hypertropia for near without glasses.
d. Convergence nearpoint is 40 mm.
e. Twenty degrees of exotropia looking up.
f. Twenty degrees of esotropia looking down.
g. Eyes level in dextroversion.
h. Elevation of the right eye in adduction.

for distance with and without glasses (fig. 11). For near the eyes could be exotropic, esotropic or straight. Looking up there was 20 degrees of exotropia, looking down, 15 degrees of esotropia. Prism cover measurements were:

c/c XT 16Δ, RH 18Δ; XT′ 14Δ, RH 9Δ.
s/c ET 14Δ, RH 9Δ; ET′ 16Δ, RH 14Δ.

	XT 6 RH 4	XT 18 RH 15	XT 14 RH 32	
Right	ET 6 RH 4	ET′ 16 RH 14	RH 22	Left
	ET 36	ET 30	ET 34	

The glasses were removed, and, when last examined in February, 1958 (fig. 12) her vision without glasses was 20/20 in both eyes and she could read four-point type at 14 inches. She had 20 degrees of exotropia for distance and looking up and 15 degrees of esotropia for near and down, while, a good deal of the time the eyes were straight. Elevation of the

right eye in adduction was still present and the eyes were level on dextroversion. Prism cover measurements were:

s/c ET 38Δ, RH 12Δ; ET′ 40Δ, RH 10Δ.

	ET 26 LH 10	ET 36 RH 20	ET 10 RH 30	
Right	ET 46 LH 5	ET 40	ET 40 RH 18	Left
	ET 50 RH 4	ET 55 RH 10	ET 50 RH 10	

Comment: This case of V-esotropia with bilateral elevation in adduction demonstrated the ability of innervational balances to operate effectively in the presence of a large lateral and vertical deviation. When the eyes were straight a latent divergence excess balanced the manifest convergence excess and a latent right hypertropia, the manifest left hypertropia.

Evidence for the presence of the latent divergence excess was the development of the large exotropia for distance and upward gaze following resection of only one lateral rectus muscle. Evidence for the existence of a latent right hypertropia was its appearance following the left inferior oblique recession.

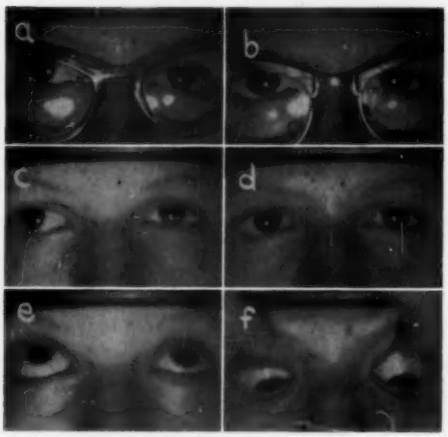

Fig. 11 (Urist) *Case 4.* June 20, 1956

a. Twenty degrees of right exotropia and 10 degrees of right hypertropia for distance with glasses.
b. Straight for near with glasses.
c. Twenty degrees of right exotropia for distance.
d. Twenty degrees of right esotropia for near.
e. Twenty degrees of exotropia looking up.
f. Ten degrees of right esotropia looking down.

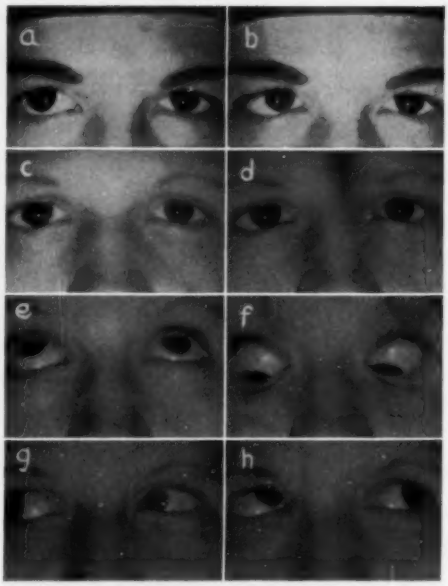

Fig. 12 (Urist) *Case 4.* February 11, 1958

a. Twenty degrees of right exotropia and 10 degrees of right hypertropia for distance.
b. Twenty degrees of right esotropia for near.
c. Eyes straight.
d. Convergence nearpoint, 40 mm.
e. Fifteen degrees of exotropia looking up.
f. Fifteen degrees of left esotropia looking down.
g. Eyes level in dextroversion.
h. Elevation of the right eye in adduction.

The ability of convergence excess to mask a large exotropia was demonstrated by the findings with prism cover measurements. Esotropia was measured in all positions of gaze even though a large exotropia was present for distance and upward gaze.

CASE 5 (4-82)

A 12-year-old girl, was seen at the Motility Clinic on March 27, 1957, giving a history of the eyes turning in since 18 months of age. Examination (fig. 13) revealed the presence of about 15 degrees of esotropia with and without glasses, straight eyes looking up and 20 degrees of esotropia looking down. Prism cover measurements were:

s/c ET 37Δ; ET′ 23Δ.

	ET 4	ET 5	ET 2	
Right	ET 20	ET′ 23	ET 22	Left
	ET 28	ET 34	ET 30	

With knowledge about this case limited to the history and cover measurements given above, a diagnosis of primary divergence insufficiency with secondary convergence excess would be logical because the esotropia was greater for distance than for near. The existence of a latent divergence excess might not even be suspected. However, the straight eyes looking up along with the large esotropia looking down were indicative of the presence of a balancing divergence excess. The diagnostic importance of the straight eyes looking up will be seen by going into the history more thoroughly.

This patient was first seen in July, 1952, at the age of seven years. At that time refraction was as follows:

O.D., +1.0D. sph. = 20/30
O.S., +1.25D. sph. = 20/30

Fifteen degrees of alternating esotropia was present. Prism cover measurements were:

c/c ET 40Δ, RH 2Δ; ET′ 40Δ.
s/c ET 40Δ; ET′ 40Δ.

	ET 30	ET 40	ET 43	
Right	ET 30	ET′ 40	ET 40	Left
	ET 30	ET 30	ET 30	

At surgery, in May, 1953, a three-mm. recession of the left medial rectus muscle and an eight-mm. resection of the left lateral rectus muscle were done. Two months after operation, in July, 1953, the eyes were straight. Prism cover measurements were:

s/c XT 5Δ, RH 3Δ; ET′ 5Δ.

	XT 16	XT 4	XT 4	
Right	XT 7	ET′ 5	XT 2	Left
	XT 5	XT 5	0	

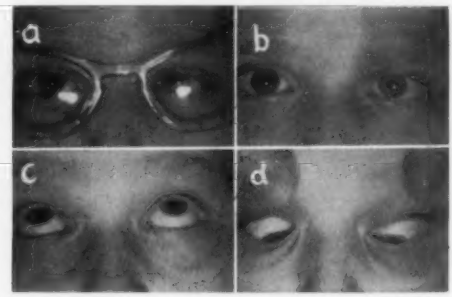

Fig. 13 (Urist). *Case 5.* March 27, 1957
a. Fifteen degrees of left esotropia with glasses.
b. Fifteen degrees of left esotropia without glasses.
c. Straight looking up.
d. Twenty degrees of right esotropia looking down.

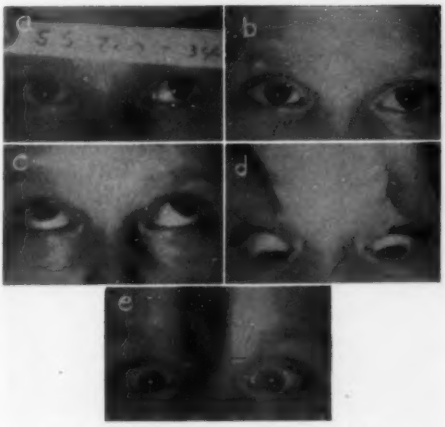

Fig. 14 (Urist). *Case 5.* April 15, 1954
a. Twenty degrees of left exotropia for distance.
b. Ten degrees of left exotropia for near.
c. Twenty degrees of exotropia looking up.
d. Straight looking down.
e. Convergence nearpoint, 40 mm.

Progressive postoperative divergence developed and on April 15, 1954 (fig. 14) she had 20 degrees of exotropia for distance, 10 degrees for near, 20 degrees looking up and straight eyes looking down. The convergence nearpoint was 40 mm. At that time the findings were diagnostic for divergence excess with secondary convergence insufficiency because of the lesser exotropia for near, the good convergence near-point and the straight eyes looking down.

At the second surgery, on August 19, 1954, a seven-mm. recession of the left lateral rectus muscle was done. One month later (fig. 15-a, b, c) the eyes were straight for distance and near, slightly divergent looking up and straight looking down. On December 10, 1954, four months after the second surgery (fig. 15-d, e, f) divergence excess was present with five to 10 degrees of exotropia for distance and looking up which was balanced by convergence excess producing straight eyes for near with 15 degrees of esotropia looking down. Prism cover measurements were:

XT 2Δ; ET′ 8Δ.

	XT 32	XT 25	XT 5	
Right	XT 27	ET 8	ET 5	Left
	ET 12	ET 8	ET 15	

However, the divergence continued to increase so that on January 3, 1957 (fig. 16) 20 degrees of exotropia was present for distance and upward gaze while the eyes were straight for near and 10 degrees convergent looking down. At that time minus 2.0D. sph. lenses were prescribed for constant use in an attempt to increase accommodative

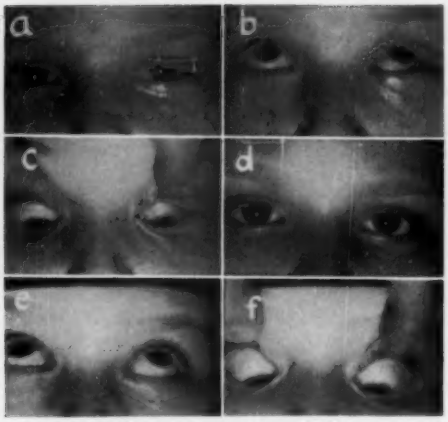

Fig. 15 (Urist) *Case 5.* September 19, 1954
a. Straight.
b. Five degrees of left exotropia looking up.
c. Straight down.

December 10, 1954

d. Straight for near.
e. Ten degrees of exotropia looking up.
f. Fifteen degrees of right esotropia looking down.

convergence and perhaps balance the exotropia for distance. On March 27, 1957, the result of this treatment was seen as in Figure 13, the stage at which this case history was first presented. With glasses the prism cover measurements were:

ET 46Δ; ET′ 46Δ.

Comment. This case was presented in reverse in order to stress the concept that, in the presence of sufficient convergence excess, an existing divergence can be masked and made latent so that esotropia will be found in all positions of gaze.

CASE 6 (1-285)

A six-year-old boy was brought to the Infirmary on January 13, 1949, with a history of the right eye turning in and up since the age of three years following polio.

Refraction and vision with atropine cycloplegia were:

O.D., +2.75D. sph. = 20/30
O.S., +2.25D. sph. = 20/20

Examination (fig. 17) revealed 20 degrees of esotropia with and without glasses and bilateral elevation in adduction.

Prism cover measurements were:

s/c ET 40Δ, RH 4Δ; ET′ 47Δ, RH 2Δ.

	ET 8 LH 2	ET 10 RH 3	ET 7 RH 8	
Right	ET 40 LH 4	ET′ 47 RH 2	ET 47 RH 6	Left
	ET 70	ET 70	ET 70	

At surgery on May 13, 1949, a four-mm. recession of the right medial rectus muscle, an eight-mm. resection of the right lateral rectus muscle and a six-mm. recession of the right inferior oblique muscle were done. Postoperative examination (fig. 18) on August 17, 1949 three months after operation, revealed 20 degrees of exotropia for distance and 45 degrees of exotropia looking up. Five to 10 degrees of esotropia were present for near

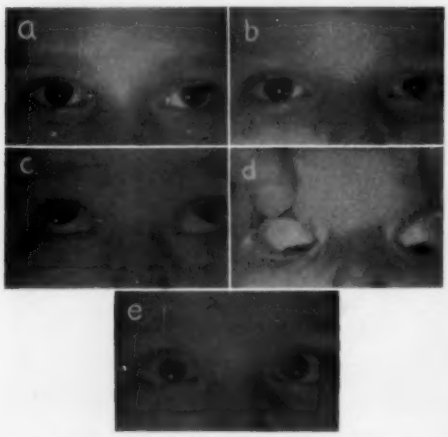

Fig. 16 (Urist). *Case 5.* January 3, 1957
a. Fifteen degrees of left exotropia for distance.
b. Straight for near.
c. Twenty degrees of exotropia looking up.
d. Ten degrees of right esotropia looking down.
e. Convergence nearpoint, 40 mm.

Fig. 17 (Urist). *Case 6.* January 12, 1949
a. Twenty degrees of right esotropia.
b. Twenty degrees left esotropia.
c. and d. Bilateral elevation in adduction.

and looking down. The left eye elevated in adduction and on levoversion the eyes were level. The convergence near-point was 40 mm.

Prism cover measurements were:

XT 15Δ; XT′ 14Δ, LH 3Δ.

	XT 40 LH 26	XT 54 LH 9	XT 56	
Right	XT 15 LH 11	XT′ 14 LH 3	XT 21 RH 3	Left
	ET 8 LH 8	ET 5	ET 2 RH 7	

At the second surgery on March 15, 1951, a seven-mm. recession of the right lateral rectus muscle was done. Postoperative examination on June 9, 1951 (fig. 19-a, b, c, d), three months after surgery, revealed 15 degrees of exotropia for distance, 25 degrees of exotropia looking up, straight eyes for near and 10 degrees of esotropia looking down. The convergence near-point was 40 mm.

Prism cover measurements were:

XT 5Δ, LH 2Δ; XT′ 8Δ, LH 5Δ.

	XT 26 LH 16	XT 32	XT 46 RH 10	
Right	ET 6 LH 12	XT′ 8 LH 5	XT 18 RH 4	Left
	ET 8	ET 8	RH 4	

At the third surgery on July 8, 1954, an eight-mm. recession of the left lateral rectus muscle was done. Postoperative examination, on April 4, 1956 (fig. 19-e, f, g, h), two years later, showed that the eyes were straight for distance and near, 15 degrees divergent looking up and slightly convergent looking down. The convergence near-point was 50 mm. Cover measurements were:

X 3Δ, LH 3Δ; LH′ 3Δ.

	XT 22 LH 18	XT 14 LH 5	XT 10	
Right	ET 4 LH 9	LH′ 2	XT 12	Left
	ET 7 LH 5	LH 2	0	

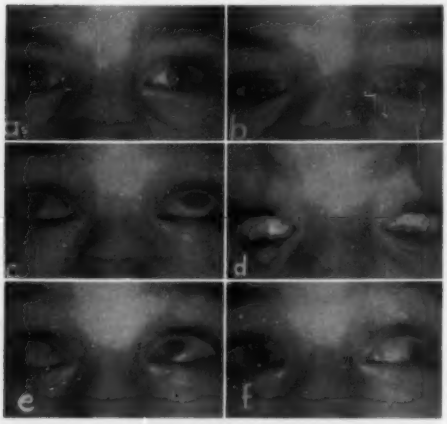

Fig. 18 (Urist). *Case 6.* August 17, 1949

a. Twenty degrees of left exotropia for distance.
b. Ten degrees of left esotropia for near.
c. Forty-five degrees of right exotropia looking up.
d. Ten degrees of left esotropia looking down.
e. Elevation of the left eye in adduction.
f. Eyes level in levoversion.

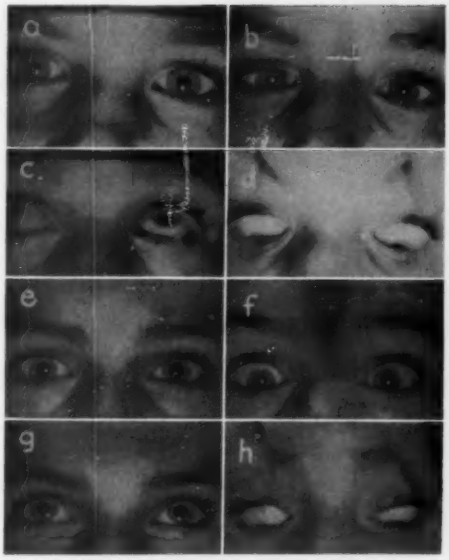

Fig. 19 (Urist). *Case 6.* June 9, 1951

a. Fifteen degrees of right exotropia for distance.
b. Convergence nearpoint, 40 mm.
c. Twenty-five degrees of exotropia looking up.
d. Ten degrees of esotropia looking down.

April 4, 1956

e. Straight.
f. Convergence nearpoint, 40 mm.
g. Fifteen degrees of exotropia looking up.
h. Straight looking down.

Comment. The development of such a marked exotropia following a four-mm. recession of one medial rectus muscle and an eight-mm. resection of one lateral rectus muscle for 20 degrees of esotropia was unusual and it was necessary to find an ex-

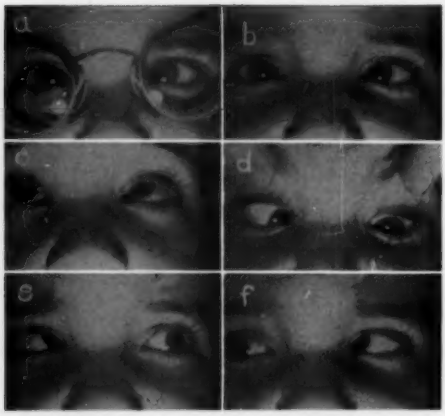

Fig. 20 (Urist). *Case 7.* September 2, 1949
a. Twenty degrees of left esotropia with glasses.
b. Twenty degrees of left esotropia without glasses.
c. Twenty degrees of left esotropia looking up.
d. Thirty-five degrees of right esotropia looking down.
e. and f. Bilateral elevation in adduction.

planation for the overcorrection. Two findings stood out in the preoperative examination, namely, (1) bilateral elevation in adduction and (2) straight eyes looking up as indicated by the small esotropia measurements. It is not improbable that the eyes may have been divergent looking up to begin with since they were not examined in that position (see Case 8).

It has been shown[3] that cases of horizontal squint with bilateral elevation in adduction and the V-syndrome have overaction of the medial rectus muscles in esotropia and overaction of the lateral rectus muscles in exotropia. Did the presence of straight eyes looking up and bilateral elevation in adduction indicate a combined overaction of both the medial rectus muscles (convergence excess) and the lateral rectus muscles (divergence excess)? The result of surgery in this case pointed in that direction for the four-mm. recession of the medial rectus muscle certainly did not produce the exotropia. In fact, it was insufficient to correct the convergence excess since esotropia remained for near and looking down. The large exotropia for distance and up following the unilateral lateral rectus resection suggested an underlying latent divergence excess (overaction of the lateral rectus muscles) was present. The straightening of the eyes following the bilateral recession of the laterals without medial rectus muscle surgery indicated that divergence excess was a basic anomaly.

CASE 7 (1-61)

A two-year-old boy was brought to the Infirmary on September 22, 1949, with a history of the left eye turning in since eight months of age.

Refraction with atropine cycloplegia was:

O.D., +4.5D. sph. ⊃ +0.5D. cyl. ax. 90°
O.S., +5.0D. sph.

Examination (fig. 20) revealed a typical V-esotropia of 20 degrees with and without glasses, bilateral elevation in adduction, 20 degrees of esotropia looking up and 35 degrees looking down. Fixation in the left eye was poor so the right eye was completely occluded until fixation was equal in both eyes. Now it was noticed that for distance the eyes were straight at times and the parents reported that at home they appeared straight for distance and near 50 percent of the time.

At surgery, September 7, 1950, a bilateral four-mm. recession of the medial rectus muscle was done. Postoperative examination on September 20, 1950, two weeks after surgery (fig. 21) showed the eyes to be straight with and without glasses, 20 degrees convergent looking down and straight looking up. The convergence near-point was 40 mm. However, for distance, with glasses, there was a

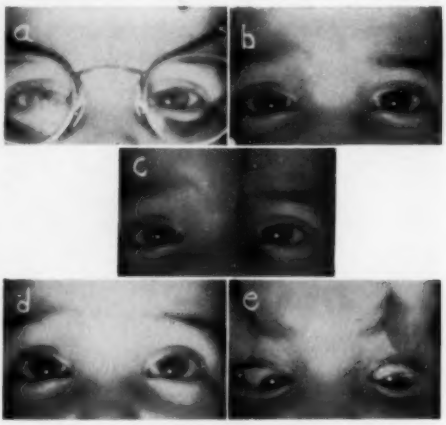

Fig. 21 (Urist). *Case 7.* September 20, 1950
a. Straight with glasses.
b. Straight without glasses.
c. Convergence nearpoint, 40 mm.
d. Straight looking up.
e. Twenty degrees of right esotropia looking down.

tendency for divergence at times so the lenses were reduced to: O.D., +2.0D. sph.; O.S., +3.0D. sph. With the reduced lenses the eyes were straight for distance.

On examination on August 15, 1951, one year postoperative (fig. 22) the eyes were straight without glasses, 15 degrees divergent looking up and 15 degrees convergent looking down. The convergence near-point was 30 mm. Bilateral elevation in adduction was present combined with apparent overaction of the lateral rectus muscles in adduction. While this was still a good result, the exotropia looking up and the increased abduction of the eyes indicated overaction of the lateral rectus muscles as the cause of the exotropia. The good convergence near-point and the 15 degrees of esotropia on looking down showed that convergence excess was still present. This balanced with the exotropia up and the eyes were straight in the central field.

On periodic subsequent examinations in the Motility Clinic the eyes were seen to be straight most of the time. However, the divergence looking up continued to increase while the convergence looking down decreased. With the lessening of the esotropia looking down to balance the exotropia looking up the eyes became divergent in primary position, and, on May 14, 1952, cover measurements were:

XT 12Δ; XT′ 8Δ.

	XT 25	XT 27 RH 5	XT 30 RH 16	
Right	XT 14	X′ 8	XT 12	Left
	ET 8	ET 5	XT 4	

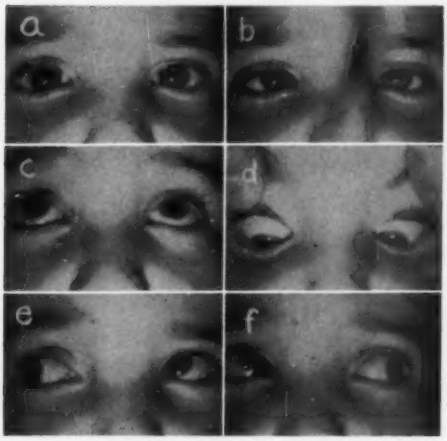

Fig. 22 (Urist). *Case 7.* August 15, 1951

a. Straight without glasses.
b. Convergence nearpoint, 30 mm.
c. Fifteen degrees of right exotropia looking up.
d. Ten degrees of left esotropia looking down.
e. and f. Bilateral elevation in adduction.

Fig. 23 (Urist). *Case 7.* June 10, 1955

a. Twenty degrees of left exotropia for distance.
b. Ten degrees of left exotropia for near.
c. Twenty degrees of exotropia looking up.
d. Ten degrees of exotropia looking down.

August 1, 1957

e. Ten degrees of exotropia for distance.
f. Convergence nearpoint remote.
g. Twenty degrees of exotropia looking up.
h. Straight looking down.

By June, 1955, five years after operation (fig. 23-a, b, c, d), examination revealed V-exotropia with 15 degrees of exotropia for near, 20 degrees of exotropia for distance, 30 degrees looking up and straight eyes looking down. The near-point of convergence was remote. Bilateral elevation was present with increased abduction of both eyes. Prism cover measurements were:

XT 32Δ; XT′ 38Δ, RH 3Δ.

	XT 54 LH 16	XT 52	XT 48 RH 20	
Right	XT 48 LH 7	XT′ 50 RH 2	XT 42 LH 18	Left
	XT 23	XT 20	XT 24 RH 8	

These findings were also consistent with a diagnosis of divergence excess and secondary convergence insufficiency in that a greater exotropia was present for distance and upward gaze than for near and looking down. To test this concept, the medial

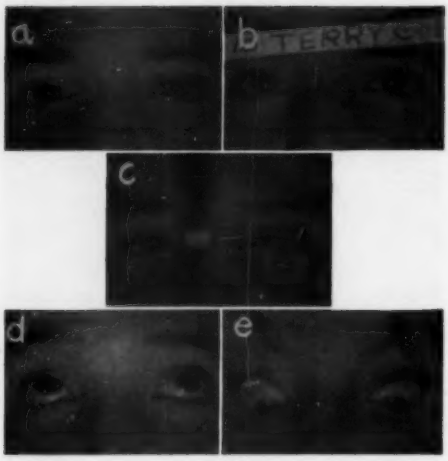

Fig. 24 (Urist). *Case 7.* October 2, 1958
a. Straight for near.
b. Five degrees of left exotropia for distance.
c. Convergence nearpoint, 40 mm.
d. Five degrees of exotropia looking up.
e. Straight looking down.

rectus recessions were not undone, but a seven-mm. recession of the left lateral rectus muscle was done on June 14, 1957, to alleviate the divergence excess. Postoperative examination on August 1, 1957 (fig. 23-e, f, g, h), revealed the presence of about 10 degrees of exotropia for distance and near, 20 degrees of exotropia looking up and straight eyes looking down. Bilateral elevation in adduction was still present but the increased abduction had diminished. He was wearing a reduced correction, +2.0D. cyl. in each eye. Cover measurements were:

s/c XT 22Δ, RH 2Δ; XT′ 30Δ, RH 3Δ.

	XT 48	XT 44	XT 34 RH 16	
Right	XT 36 LH 6	XT 30 RH 3	XT 25 RH 10	Left
	XT 22 LH 4	XT 15	XT 12 RH 2	

Examination on October 2, 1958, 16 months after the second surgery (fig. 24) revealed straight eyes for near and looking down, five degrees of exotropia for distance and 10 degrees of exotropia looking up. The convergence nearpoint was now 30 mm.

Comment. The history obtained from the patient's parents stating that the eyes were straight (50 percent of the time) at home was important because it indicated that enough latent divergence excess was present to balance the 20 degrees of esotropia. The reaction to the bilateral four-mm. recession of the medial rectus muscles was instructive. Two weeks after surgery the eyes were straight for near and looking up, while, for distance, exotropia was seen at times. This meant that a manifest divergence excess had developed. Convergence excess was still present, as seen by the 20 degrees of esotropia looking down, but decreased from 35 degrees before surgery. The divergence excess progressed to such an extent that it produced a secondary convergence insufficiency manifested by the development of a lesser exotropia for near and down. If the convergence insufficiency had been primary the exotropia would have been greater for near and down than for distance and up. When some of the divergence excess was alleviated by a recession of one lateral rectus muscle the eyes became straight for near and looking down and the convergence nearpoint much improved, while, for distance and looking up only a small exotropia remained.

This case again demonstrated that in V-esotropia with bilateral elevation in adduction and straight eyes for distance latent divergence excess was present. The bilateral medial rectus muscle recessions eliminated too much of the convergence excess and allowed the latent divergence excess to become manifest. Innervational balances may occur slowly and it took a year after the recession of one lateral rectus for the eyes to become straight for near.

CASE 8 (2-226)

A 17-year-old girl came to the Infirmary on April 6, 1950, with a history of the left eye turning in since the age of one year which she wanted to have straightened.

Refraction and vision with homatropine cycloplegia were:

O.D., +2.75D. sph. = 20/15
O.S., +3.5D. sph. ⊃ +0.5D. cyl. ax. 90° = 20/200

Examination (fig. 25) showed that the eyes were straight with and without glasses for distance while for near 10 degrees of esotropia was present.

Divergence excess was manifested by the presence of 30 degrees of exotropia on looking up and convergence excess by 30 degrees of esotropia looking down. There was marked elevation of the left eye in adduction. Cover measurements of esotropia looking up demonstrated the masking of the exotropia by the convergence excess. They were:

c/c LH 4Δ; ET′ 34Δ, LH 4Δ.
s/c ET 36Δ, LH 6Δ; ET′ 44Δ, LH 5Δ.

	ET 5 LH 36	ET 2 LH 10	ET 8 LH 10	
Right	ET 30 LH 10	ET′ 44 LH 5	ET 44	Left
	ET 56	ET 60	ET 66	

The subjective angle was at eight-prism diopters base-in, the objective angle at 10 prism diopters base-out and the convergence near-point was 30 mm.

Again, as in Case 3, it was decided to alleviate the large vertical deviation and on March 7, 1950, a 10-mm. recession of the left inferior oblique muscle was done. Postoperative examination in April, 1952 (fig. 26), two years after surgery, revealed the eyes to be straight with and without glasses for distance. For near, 10 degrees of esotropia was present without glasses. Looking up there was 25 degrees of exotropia and looking down, 25 degrees of esotropia. Elevation of the left eye in adduction was still present but much improved. Cover measurements, after wearing no glasses for one week, were:

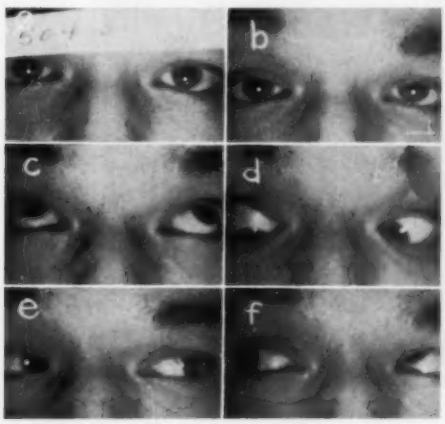

Fig. 25 (Urist). *Case 8.* April 10, 1950
a. Straight for distance without glasses.
b. Ten degrees of left esotropia for near.
c. Thirty degrees of left exotropia looking up.
d. Thirty degrees of left esotropia looking down.
e. Eyes level on levoversion.
f. Marked elevation of the left eye in adduction.

s/c ET 20Δ, LH 1Δ; ET′ 30Δ.

	ET 8 LH 3	ET 7	ET 8	
Right	ET 28 LH 2	ET′ 30 LH 2	ET 37	Left
	ET 44 LH 5	ET 40 LH 3	ET 50	

The objective and subjective angles were found at ET 30Δ, LH 2Δ. The convergence near-point was 60 mm.

Comment. The subjective angle of 8Δ base-in for distance and the 25 degrees of exotropia on upward gaze indicated the presence of divergence excess. However, convergence excess was so prominent that the exotropia was masked and only four prism diopters of left hyperphoria was found with glasses for distance and 2Δ of esotropia on upward gaze with cover meas-

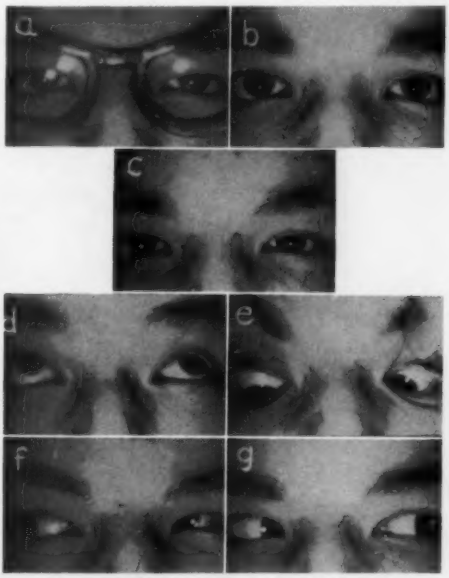

Fig. 26 (Urist). *Case 8.* September 4, 1952
a. Straight with glasses for distance.
b. Straight for distance without glasses.
c. Ten degrees of left esotropia for near without glasses.
d. Twenty-five degrees of exotropia looking up.
e. Twenty-five degrees of esotropia looking down.
f. Elevation of the left eye in adduction.
g. Eyes level on levoversion.

urements. The left hypertropia was improved with surgery but little effect was noted on the horizontal deviation. With the presence of such a large exotropia (30 degrees) looking up it probably took all of the excess convergence the patient had, 30 degrees of esotropia on downward gaze, to hold the eyes straight for distance.

Knowing that a certain amount of excess convergence was necessary to control the divergence excess for distance, the surgeon, when operating for the esotropia, will be prepared for any adverse results. For example, a four-mm. recession of one medial rectus muscle would most probably help the esotropia for near but could be expected to produce a manifest exotropia for distance. The procedure would be in the form of a calculated risk and the surgeon could prepare the patient for a planned second surgical procedure, namely, recession of the lateral rectus muscles. He would not be amazed at the development of the exotropia following such a minimal recession and probably would not hasten to undo the medial rectus surgery, thinking the muscle had slipped or was overrecessed.

Toward cases that had what was probably a manifest divergence excess along with a masked convergence excess, Sugar[4] has been bolder in his approach. Anticipating the development of esotropia following lateral rectus recessions for the exotropia, he has pioneered in combining recessions of the lateral rectus muscles with a unilateral medial rectus recession as a single surgical procedure, with good results.

CASE 9 (107)

A five-year-old boy was brought to the Infirmary on April 20, 1949, with a history of crossed eyes since birth.

Refraction with atropine cycloplegia was:

O.D., +2.0D. sph. = 20/50
O.S., +2.0D. sph. = 20/200

The right eye was occluded and vision in the left eye improved to 20/30 by June 4, 1949. Examination on October 24, 1950 (fig. 27) revealed 25 degrees of esotropia for distance and near. At times the eyes were seen to be straight with glasses for distance and 10 degrees convergent without glasses.

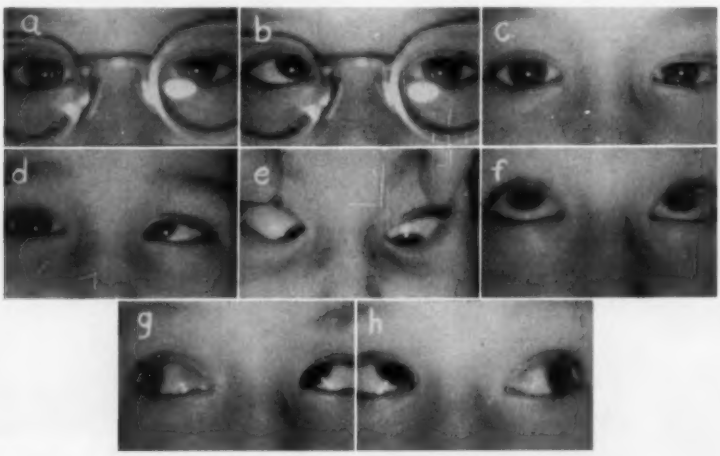

Fig. 27 (Urist). *Case 9.* October 24, 1950.

a. Straight for distance with glasses.
b. Thirty-five degrees of left esotropia, 10 degrees of left hypertropia with glasses for near.
c. Fifteen degrees of left esotropia for distance without glasses.
d. Thirty-five degrees of left esotropia without glasses for near.
e. Forty-five degrees of right esotropia looking down.
f. Straight looking up.
g. and h. Bilateral elevation in adduction.

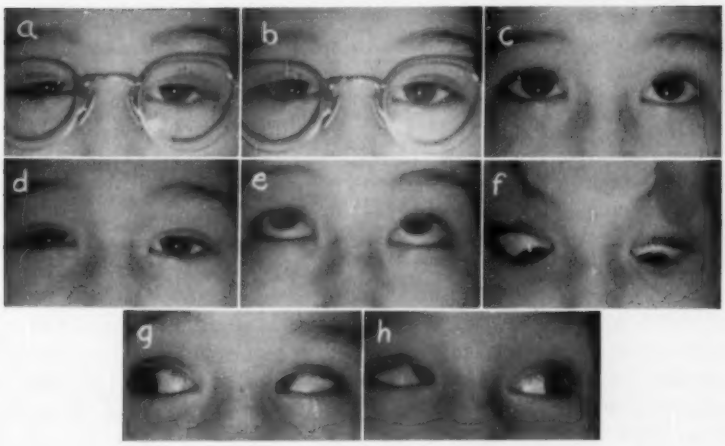

Fig. 28 (Urist). *Case 9.* January 2, 1952

a. Straight for near with glasses.
b. Straight for distance with glasses.
c. Straight for distance without glasses (looking over camera).
d. Straight for near without glasses.
e. Straight looking up.
f. Ten degrees of right esotropia looking down.
g. and h. Bilateral elevation in adduction still present.

Looking up the eyes were straight, looking down 40 degrees convergent and in adduction there was bilateral elevation of the eyes. Prism cover measurements were:

c/c ET 54Δ, RH 8Δ; ET′ 67Δ, RH 10Δ.
s/c ET 65Δ, RH 8Δ; ET′ 75Δ, RH 10Δ.

	ET 45 LH 8	ET 48	ET 54 RH 10	
Right	ET 65	ET′ 75 RH 10	ET 62	Left
	ET 75	ET 75	ET 70	

This was a clear-cut case of convergence excess and V-esotropia, and, for the amount of esotropia he had, a bilateral four-mm. recession of the medial rectus muscles would have been a conservative procedure. However, the presence of bilateral elevation in adduction and straight eyes looking up and for distance at times indicated the presence of a latent divergence excess. To test this, at surgery, on May 25, 1951, only the left medial rectus was recessed four mm. Immediately postoperative, 15 to 20 degrees of esotropia was present but the eyes remained straight on looking up all the time. The esotropia gradually improved and the eyes straightened until, when examined on January 2, 1952, seven months after operation (fig. 28) the eyes were straight for distance and near both with and without glasses, straight looking up and 10 degrees convergent looking down. Bilateral elevation in adduction was still present.

Prism cover measurements were:

c/c LH 2Δ; E′ 7Δ, LH 5Δ.
s/c RH 2Δ; E′ 8Δ.

	LH 2	RH 2	ET 7 RH 12	
Right	ET 20	E′ 8	ET 20 RH 10	Left
	ET 24	ET 20	ET 25	

When last seen on June 12, 1956, he had grade II fusion at four prism diopters base-in, RH 4Δ. Cover measurements were:

X 4Δ; Ortho′.

The lenses were reduced because of the exophoria for distance.

Comment. The straight eyes for distance and upward gaze along with the bilateral elevation in adduction was indicative of the presence of a combined anomaly, namely, convergence excess and latent divergence excess. With this idea in mind a four-mm. recession of one medial rectus muscle was done. This small amount of recession would not usually correct 25 degrees of esotropia.

The rationale behind this procedure was to remove enough of the convergence excess and still allow a sufficient amount to remain to balance with the latent divergence and produce straight eyes. The result following surgery was as anticipated but took place slowly. The diagnosis of latent divergence excess was substantiated at the last examination by the findings of exophoria for distance with orthophoria for near.

Summary and Conclusions

Cases of V-syndrome were presented with obvious combined anomalies of divergence excess and convergence excess. They had exotropia for distance and looking up and esotropia for near and down. At times the eyes were straight in the central field of gaze. It was postulated that in order for the eyes to become straight an innervational balance occurred between the opposite deviations.

Other cases of V-esotropia were presented in which a manifest convergence excess was combined with a latent or masked divergence excess. These cases had bilateral elevation in adduction with a greater esotropia for near and looking down than for distance and upward gaze. The basis for the diagnosis of latent divergence excess was the occasional presence of straight eyes for distance and/or upward gaze. It was postulated that the straightening of the esotropia for distance and upward gaze was due to the action of a latent divergence excess as the balancing innervational mechanism.

Cases of V-esotropia with bilateral elevation in adduction with straight eyes for distance and/or upward gaze were overcorrected with minimal amounts of surgery as follows:

1. When bilateral medial rectus recessions were done and the convergence excess eliminated, the latent divergence excess became manifest by a marked exotropia for distance and upward gaze. This was because there was insufficient remaining convergence excess after surgery to balance the existing latent divergence excess.

2. When resections of the lateral rectus muscles were done exotropia again developed for distance and upward gaze. The explanation for this was that before surgery the convergence excess balanced with the divergence excess. When the divergence excess was surgically increased the balance was upset and exotropia became manifest.

3. In the presence of bilateral elevation in adduction where only a unilateral hypertropia was manifest its surgical correction allowed the opposite latent hypertropia to appear.

Treatment of this last group of V-esotropia should be directed toward improving the excess convergence for near and looking down without upsetting the existing balance with divergence excess for distance and upward gaze. In the presence of a large accommodative component conservative treatment with glasses is indicated since the convergence excess factor would be expected to diminish with age and growth changes. In many cases the added use of bifocals or miotics has been of great help and should be given a trial.

Surgery, when indicated, must aim at relieving only enough convergence excess to permit a gradual innervational adjustment to take place. A unilateral medial rectus recession operation would accomplish this. If surgery is indicated for the bilateral elevation in adduction, that is, if unsightly elevation persists after the eyes become straight, bilateral inferior oblique recessions should be done even though only one type of hypertropia was found in the central field.

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BIO-ASSAY FOR AN EXOPHTHALMOS-PRODUCING SUBSTANCE IN HUMAN SERUM USING THE ATLANTIC MINNOW*

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Introduction

The observation that anterior pituitary extract will produce exophthalmos when injected into the Atlantic minnow was noted by Albert,[1] in 1945. Subsequently attempts have been made to use this test animal to assay human sera for the presence of an exophthalmos-producing substance. Dobyns[2] reported success using unaltered human serum in a series of six patients displaying various stages of exophthalmos related to endocrine dysfunction. His results further suggested a relationship between the stage and severity of the patients' exophthalmos and the degree of response in the fish.

The purpose of this study was to determine whether or not such an exophthalmic-stimulating factor could be demonstrated in the sera of 21 patients with endocrine exophthalmos.

Methods and subject material

Biologic test system

The test animals (Fundulus heteroclitus) were obtained in groups of 200 from Charles Comstock, Saugus, Massachusetts, between the months of January to June. The fish were separated into two groups and stored in both glass and galvanized tanks in dechlorinated tap water at 70°F. At the time of injection with either human serum, pituitary extracts or saline the fish were isolated in glass bowls in groups of five. Materials tested were injected into the coelomic cavity with a No. 26 needle through the vent and bowel wall. The quantity injected was 0.3 cc. repeated at four, eight, 24, and 48 hours for a total volume of 1.2 cc. The fish were observed daily for periods of two to three weeks following the injections.

Experimental design

Each series of tests consisted of injecting four groups of fish with the following materials: *Group 1*, serum from exophthalmic patients; *Group 2*, serum from normal humans; *Group 3*, saline; *Group 4*, thyrotropic extract (Thyotropar, Armour). Fresh serum was used initially and the remainder frozen at 0°F. to be used one to two months later.

Selection of patients

The exophthalmic patients from whom the serum was obtained represented different phases of the endocrine eye lesion[3,4] including patients with so-called malignant or progressive exophthalmos. Data pertaining to each patient are presented in Table 1.

The diagnosis of thyrotoxicosis was based on basal metabolism-rate values, protein bound iodine determination, the I^{131} uptake at four and 24 hours, and upon the clinical judgment of members of the Thyroid Clinic† In cases of exophthalmos without demonstrable evidence of thyrotoxicosis, the diagnosis of endocrine exophthalmos was based

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TABLE 1

PATIENTS FROM WHOM SERA WERE OBTAINED FOR ASSAY

No.	Age (yr.)	Increase in Exophthalmos		Toxic	Prior Rx	Phase of the Eye Lesion	Bio-Assay Response
		O.D.	O.S.				
		(mm.)					
1	50	2.0	2.5	No	I^{131} (4X)	Stationary	Negative
2	29	2.0	2.0	Yes	None	Early-active	Negative
3	6	Maximum O.U.		No	I^{131} (3X)	Stationary	Negative
4	61	8.5	7.5	No	I^{131} (2X)	Stationary	Negative
5	54	2.0	1.0	No	I^{131} (1X)	Stationary	Negative
6	37	3.5	4.5	No	I^{131} (1X)	Active	Negative
7	50	Maximum O.U.		Yes	None	Early-active	Negative
8	20	2.0	1.5	Yes	I^{131} (1X)	Active	Negative
9	50	Maximum O.U.		?	None	Active	Negative
10	57	1.5	2.0	No	I^{131} (2X)	Progressive	Negative
11	19	1.5	1.5	Yes	I^{131} (2X)	Active	Negative
12	12	Maximum O.U.		Yes	I^{131} (1X)	Active	Negative
13	40	4.0	5.0	Yes	I^{131} (1X)	Active-severe	Negative
14	52	3.0	3.5	No	T-3	Active-severe	Negative
15	26	Maximum O.U.		No	I^{131} (4X)	Stationary	Negative
16	12	Maximum O.U.		Yes	None	Early-active	Negative
17	37	1.5	1.5	No	I^{131} (4X)	Stationary	Negative
18	46	4.5	2.5	Yes	I^{131} (1X)	Progressive	Negative
19	24	1.5	1.5	No	I^{131} (1X)	Stationary	Negative
20	37	2.0	2.0	Yes	I^{131} (1X)	Active	Negative
21	50	2.5	4.0	No	I^{131} (2X)	Progressive	Negative

on the Werner's test[5] and the absence of demonstrable intraorbital and intracranial pathology. The average single dose of I^{131} used for treatment was 4.6 mc. As indicated in Table 1, multiple therapy doses were frequently required to attain a euthyroid state.

Because of the wide range of normal values for exophthalmometry, Table 1 lists measured increases in exophthalmos in most instances. Disregarding apparent proptosis due to lid retraction these patients, however, all appeared grossly exophthalmic. The onset of exophthalmos in some cases occurred before they were first seen and measured in the Thyroid Clinic. Therefore, the recorded increases do not represent the total or maximum increases in all cases. In the event the exophthalmos had reached its greatest extent by the time the patient was first examined it was designated simply as maximum. The actual exophthalmometric measurements in these cases were usually greater than 20 mm. in adults and 17 mm. in children. For normal persons in this locality the range for exophthalmometric readings using a Hertel type exophthalmometer (Krahn, Hamburg, Germany) was 10.5 mm.-18.5 mm.[3,4]

RESULTS AND DISCUSSION

In these experiments the normal control sera, the 0.9-percent NaCl solution, and the sera obtained from patients with endocrine exophthalmos failed to stimulate measurable exophthalmos in the test minnow. To the contrary the minnows of Group 4 injected with TSH extracts consistently developed proptosis. The exophthalmos was first observed two to three hours after injection, reached a peak in 24 hours, and receded to pre-injection levels on the second and third day.

The test under consideration is based upon several assumptions. First, that the exophthalmos in the patients was related to an exophthalmic-producing substance (EPS) in their sera; secondly, that it was identical to or similar to the EPS-TSH of the pituitary gland; and, finally, that it would be present in undiluated sera in amounts capable of producing proptosis in the minnow.

Also, if the hypothesis which holds that there is a reciprocal relationship between pituitary and thyroid gland functions and the development of exophthalmos is true, some of our patients should have had high

levels of exophthalmic-producing factor. The sera for testing was obtained from patients who had severe endocrine eye reactions at various stages of advancing proptosis and who also had various degrees of thyroid activity ranging from the untreated thyrotoxic state to the patient recently made euthyroid with iodine-^{131}. Patients with newly attained euthyroid state and advancing proptosis would be expected to have large amounts of exophthalmic-producing substance in their sera. Had the minnows developed exophthalmos, the above assumptions would have been handsomely supported.

Our results, however, did not support either these contentions or the results described by Dobyns[2] in a small number of cases. It is possible that such changes as have been described[2] can be altered on the basis of chemical constituents of the water, seasonal changes, temperature variations, or other unknown factors enhancing the reaction. It is also possible that there is no increase in the pituitarylike EPS in the serum. The numerous reports[6-8] of patients having loss of pituitary function yet capable of sustaining a thyrotoxic gland and even exophthalmos casts some doubt on the exclusive role of the pituitary gland in production of the endocrine eye lesion.

As desirable as it would be to have a readily available test for an exophthalmic principle, we do not believe the biologic assay used in these studies can be relied upon to detect an exophthalmic-producing substance in undiluted human serum.

Summary and Conclusions

In these studies the Atlantic minnow consistently developed exophthalmos in response to injections of a commercially prepared pituitary extract. The injections, however, of test sera obtained from 21 patients with all phases of the endocrine eye lesion into these fish failed to produce a detectable exophthalmos. Thus in our experience this biologic assay using the Atlantic minnow did not detect an exophthalmic-producing principle in the sera of patients with endocrine exophthalmos.

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NORMAL VITREOUS LOSS*

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Any ophthalmic surgeon who operates frequently has experienced loss of vitreous. While such an occurrence is rare today, the sudden, unexpected presentation of normal, formed vitreous is dramatic, tragic, and not forgotten by the surgeon or his assistant, and often the end-result is poor. The term "bead of vitreous," is usually used only by a surgeon describing his own surgery but, even so, a very small loss may be just as serious or even worse than a larger amount of loss, if the vitreous or hyaloid remains attached to the wound.

The reason for choosing this subject was that, after a long period of complacency on my part, two of my patients sustained loss of vitreous within a short period of time. In my cases, the "beads" were of large size. In one case, this was due to poor surgical judgment in putting air into the anterior chamber after having lost only degenerated fluid vitreous. This resulted in a large "bead" of formed vitreous being pushed out. The second case was due to a severe choking spell at the time of lens delivery in a patient who, apparently, had been under perfect sedation and control.

There is much in the literature on prevention but very little on what to do if loss does occur. The very fact that vitreous loss rarely is encountered with modern techniques may cause some surgeons to be less alert as to what to do at such a time. Much depends upon skill and judgment and recognition of what factors are involved in later complications. It should be recognized that adhesion of the hyaloid or the vitreous to the operative wound is most dangerous. Means to prevent or reduce this complication is the most important factor involved in the emergency.

Normal vitreous does not flow out of the eye naturally. It is either pushed out by the surgeon or expressed by the patient and, in the latter case, it is still the surgeon's responsibility. In general, by being alert to signs of possible danger, loss of vitreous may often be prevented, which after all is the best treatment.

The safeguards in prevention of vitreous loss in advance of surgery are not within the scope of this paper. But it is assumed that adequate study and preparation have been carried out according to the needs of the individual patient.

SAFEGUARDS AT TIME OF SURGERY

The patient should be comfortable and relaxed, not wanting to move or squeeze; in fact, not being able to do so if he wishes. The so-called "bad actor" of former days is our responsibility today. There should be oxygen or fresh air piped under the drapes for comfortable breathing. This adds greatly to the prevention of nausea and coughing.

Painful injections are to be avoided by using a skin wheel of Novocaine and "floating" the needle in by injecting a little of the anesthetic ahead of the needle. This usually requires a little more of the anesthetic agent in the syringe. This also is a good way to prevent retrobulbar hemorrhage. Any marked or increasing proptosis from a retrobulbar hemorrhage before the eyeball is opened indicates postponement of surgery.

The speculum or lid sutures should be routinely checked for pressure upon the globe before starting surgery and again just before lens delivery. Some types of speculums should be partially closed before lens delivery, leaving just enough room for the next procedure.

It is well to check for inferior oblique action, after an apparently good retrobulbar injection. Gifford[1] has reported that action

* From the Thayer Hospital. Presented before the New England Ophthalmological Society, Boston, Massachusetts, November 18, 1959.

of this muscle alone can cause a considerable increase in vitreous pressure. Added anesthesia is indicated if the oblique muscle is still active. If a superior rectus suture is used, it should always be placed well back in the muscle and released before delivery of the lens. If this area has been properly injected with the anesthetic, the eye will stay down in good position.

In severely complicated cataracts, especially in the event of a dislocated lens, the use of the Flieringer ring has been of considerable advantage in my hands. When using one of the rings, there should be eight attachments to the globe, including each of the four main recti tendons. Its purpose is to hold the anterior segment of the globe rigid, thus helping to prevent vitreous loss. With eyes previously recognized as dangerous, Kirby[2] advocated preplaced sutures. If they are best for dangerous eyes, it is a very comfortable feeling to have them present in all cataract cases.

Very slow delivery of the lens through the wound helps prevent a rupture of the hyaloid. This is particularly important when there is an adhesion of the posterior capsule to the hyaloid. Reese[3] has stressed the importance of such adhesions as a frequent cause of hyaloid tears. If while tying the sutures the anterior chamber fills rapidly, it indicates a tear in the hyaloid and vitreous in the anterior chamber. This is usually not dangerous, if gentle technique is used. If the wound looks tight and there is no presentation of vitreous, there should be no unnecessary manipulation and extra postplaced sutures should not be added. No air should be injected into the anterior chamber, as this may cause a vitreous prolapse. By the first dressing, the chamber is usually reformed by aqueous. In the toilet of the wound, just lifting up the corneal flap often allows the iris to fall back into place. If it becomes necessary to use an iris repositor, the instrument should never pass over the pupillary border of the iris where it might rupture the hyaloid.

Creasing of the cornea and a horizontal fold indicates increased vitreous pressure. Gaping or "fish mouth" opening of the wound signifies impending vitreous loss. With a gaping wound before lens delivery, the lens is usually pushed up and forward by the vitreous pressure. There is never space in the anterior chamber for the safe application of the erisophake or forceps. Often the capsule can be grasped near the upper pole and the lens teased out with little or no counter pressure.

When using zonulolysis, we are dealing with a partial or totally luxated lens and light counter pressure below is a safeguard against the lens slipping away from the forceps. In such instances, the lens can be held up in position until a reapplication of the forceps is made. The neutralizing irrigation after zonulolysis should be directed only into the anterior chamber, never behind the iris because of the danger of rupturing the hyaloid.

Last, but of the greatest importance, is the routine use of digital pressure on the globe immediately after the retrobulbar injection. Five minutes should be the minimum and longer if needed to produce hypotony. The pressure also helps to diffuse the anesthetic into the ocular muscles. Pressure is released every minute to prevent impairment of circulation. Diamox or intravenous urea should be used when indicated in glaucoma patients.

All of these procedures should be routine and the omission of any one of them may cause loss of formed vitreous.

When vitreous loss occurs

Various procedures are used by different surgeons in the event of vitreous prolapse. Most textbooks, including Kirby's[2] excellent publication, advise cutting off the prolapsed vitreous flush with the wound and "getting out" as quickly as possible. Obviously this procedure ignores the principle cause of late complications, namely the adhesion of the vitreous to the wound.

Some surgeons have advocated pressing out more vitreous if a small loss occurs, on the theory that the remaining vitreous will then retract back from the wound after the prolapse is cut off. Depending upon the cause of the prolapse, it would seem that a massive loss of vitreous could easily result. This would be disastrous unless stored vitreous is used to replace the loss.

Trying to free the wound of vitreous by inserting a spatula between the sutures in the area of the prolapse will only result in further loss.

Cutting the iris sphincter below at the 6-o'clock position, to prevent an updrawn pupil, is used by many surgeons and there are special scissors designed for this purpose. This procedure may have its place when one is not able to free the wound of vitreous strands. However, since the principle cause of late sequelae is the adhesion of the vitreous to the wound, one should be prepared to do everything possible to prevent this complication, either totally or in degree. Adhesion of the vitreous strands to the wound often causes an updrawn pupil, glaucoma, separation of the retina, or uveitis.

To accomplish this objective, it is well to choose carefully from several advocated procedures and have a definite plan in case of such an emergency.

In all cases, one should try to recognize the cause of the vitreous prolapse, and remove or lessen this factor. If it is due to external pressure from the speculum, it can often be relieved by lifting the instrument. Atkinson[4] suggests that, when such a cause is found and removed, it is better to hold the wound open to allow the vitreous to retract rather than to sew it up tightly at once.

In case the patient is vomiting, a suture or two should be tied at once if possible. If vomiting continues, it will be necessary to remove the speculum and put a moist pad over the closed lid until the patient is quiet. If sutures are not already tied, one must be sure the corneal flap is not everted under the lid.

When vitreous presents in the wound before lens delivery, much depends upon the area of prolapse. If at one extremity, the lens often may be grasped from above with forceps and gently teased out with little or no counter pressure. Vail[8] favors his modified Smith-Indian method of pressure above and below. At any rate, the lens must be removed and it may be necessary to slide a spoon or loop under the posterior capsule and deliver with counter pressure below, holding the lens up against the cornea with the spoon.

When vitreous is lost after the delivery of the lens and it cannot be made to retract by eliminating the cause, the preplaced sutures should be tied. Additional sutures must be postplaced carefully and slowly. This is always difficult and, to quote a resident at the Massachusetts Eye and Ear Infirmary, "working in vitreous is like eating jello with chop sticks." In all cases of vitreous loss, a total of five or six sutures should be utilized. It is well to remember that one poorly placed suture may cause a poor closure of the wound. It should be done carefully and deliberately, as much depends upon a good tight closure of the wound.

All sutures should be tied, with the exception of the temporal suture which is left untied, cutting off the vitreous flush with the wound. Hogan[6] advises picking up the vitreous prolapse with the vacuum of a large mouthed eye dropper and pulling it out on a stretch when cutting, as the vitreous may then retract from the wound.

With all but the temporal suture tied, air can be injected very carefully into the anterior chamber. If this causes further prolapse, this vitreous should be cut off again.

At this point, McLean[7] instills a strong miotic, preferably acetylcholine, directly into the anterior chamber. This works best with a round pupil, which he uses routinely only doing a complete iridectomy when necessary, due to iris prolapse. The constriction of the pupil occurring around the vitreous prolapse tends to hold back the main body of vitreous.

The next procedure is to pass a thin iris spatula into the anterior chamber through

the opening in the wound left by the untied temporal suture. The point of the spatula is passed over the surface of the iris up under the vitreous prolapse. It is swept along the inner aspect of the wound under the prolapse and down across the pupil to cut the strands of the projecting vitreous free from the main body of vitreous.

Castroviejo[8] follows a similar technique, using a cyclodialysis spatula and injecting air after the maneuver. He applies eserine ointment after closing the wound. If a retrobulbar injection has been used, eserine will not act for some time but he feels that the action is adequate.

Next the temporal suture is tied, making sure there is air in the anterior chamber at this time, then removing any obvious remnants of vitreous from the wound. The head of the patient should be kept elevated so that the air is between the vitreous and the wound.

In massive losses of vitreous, Shaffer[9] reports excellent results with implantation of stored vitreous injected between the sutures.

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ACTION OF DI-ISOPROPYL-FLUOROPHOSPHATE ON CYCLODIALYSIS CLEFTS*

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Cyclodialysis has been a popular operation in Europe since 1905 when Heine[1] first introduced it. In this country where, until recently, its use has been restricted chiefly to aphakic glaucoma, interest in this operation has been increasing in recent years since gonioscopy has made it possible to understand and define the surgical indications. With the aid of gonioscopy one is better able to explain the mode of action of the operation and to account for failures.

MODE OF ACTION: GONIOSCOPIC STUDY

Heine postulated that the tension-lowering action of cyclodialysis was dependent on the formation of an internal fistula through which aqueous was drained from the anterior chamber into the suprachoroidal space, where it was absorbed by the choroidal vessels. Elschnig[2] confirmed histologically the presence of a communication between the anterior chamber and the suprachoroidal space after cyclodialysis.

It is of interest to correlate the gonioscopic findings with the effect of the operation on the intraocular pressure. Sugar,[3, 4] in a long-range follow-up of cases of cyclodialysis, found an open cleft in most of his controlled cases and no visible cleft in his uncontrolled cases.

Gonioscopically, a cleft can be demonstrated in many eyes in which cyclodialysis has normalized the tension. After a well-executed operation, one should see a cleft be-

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tween the scleral spur and the ciliary body. Since the operation is done without visual control, the position of the cleft is bound to vary. The success or failure of the operation appears to depend on the position of the cleft. The cleft varies in size from a narrow barely visible slit to a wide gaping opening.

A patent cleft, visible gonioscopically in the immediate postoperative period, may close subsequently. In some uncontrolled eyes a shallow cleft is visible gonioscopically and the failure may be due to postoperative inflammatory adhesions between the choroid and the sclera behind the cleft. On the other hand, in some controlled eyes the cleft is filled with loose fibrous tissue which presumably is not dense enough to interfere with drainage of aqueous into the suprachoroidal space. In other controlled cases, some anterior peripheral synechias of thin atrophic iris may conceal the cleft from view but, apparently, without preventing drainage through the cleft.

Finally, in a small number of eyes with controlled tension, the cleft cannot be found on gonioscopic examination. It is possible that in such cases the cyclodialysis spatula detached the posterior portion of the trabecular bands (functional trabeculae) which overlie the canal of Schlemm. Stripping of the trabecular meshwork from the canal of Schlemm might result in direct communication between the anterior chamber and the canal and provide an alternate route of drainage other than the cleft. This explanation is supported by an occasional gonioscopic finding of thin membranous structures adherent to the ciliary body and the scleral spur. These could possibly consist of detached and lacerated trabecular bands. It would seem desirable to detach the trabecular bands from their insertion at the spur but this is technically difficult to accomplish with the present instrumentation since the spatula tends to glide over the spur and trabeculae.

From gonioscopic observation it may be concluded that, in general, a properly placed and permanently patent cleft is a prerequisite for the maintenance of normal intraocular pressure after cyclodialysis.

Effect of DFP on patency of cyclodialysis cleft

The most important cause of failure of cyclodialysis to maintain normal tension is the tendency of the cleft to close in the early postoperative stage because of approximation of the raw surfaces of the cleft. If the edges of the cleft can be kept apart during this stage, the permanency of the results is assured in most cases.

Sugar[5] noted that the cyclodialysis cleft may regain its patency under eserine therapy. I found DFP more effective in keeping the cleft open. The beneficial effect of DFP was first observed in the case of a young woman after cyclodialysis for glaucoma following extraction of a traumatic cataract. Shortly after the cyclodialysis the tension became elevated and could not be controlled with pilocarpine. A cleft could not be seen gonioscopically at the site of the cyclodialysis. Since the patient refused to undergo further surgery, it was decided to try DFP. She was advised to instill one drop of 0.1-percent solution three times daily. When she returned a few days later, the tension was normal. Gonioscopically, a narrow cleft was visible this time. Normal tension was maintained for several months, while under observation, with one instillation of DFP every two days.

The effect of DFP on the cyclodialysis cleft has been verified by me gonioscopically in 15 cases. It is possible to explain the action of DFP by the powerful contraction of the ciliary muscle engendered by this drug. The pull which this muscle exerts on the scleral spur becomes effective in the region of the cyclodialysis and results in a gaping of the cleft.

Another mode of action of DFP may be through the powerful effect on the sphincter of the pupil. In extreme miosis the iris is pulled away from the angle and, in an eye

with a rather narrow angle, this retards formation of anterior peripheral synechias which would ultimately block the approach to the cleft.

DFP should be used once daily beginning with the first postoperative day and continuing for several weeks. The contraction of the ciliary muscle produced by this drug tends to keep the cleft patent until the margins have become fibrosed and there is less tendency for the cleft to close. In some cases the tension becomes elevated after DFP is discontinued and returns to normal with the resumption of the drug, as in the following case.

E. G., a 53-year-old woman, when first seen in October, 1957, had tensions of 35 mm. Hg in the right eye and 49 mm. Hg in the left eye. On the basis of gonioscopic examination, a diagnosis of chronic simple glaucoma was made. Since miotics failed to control the tension, a cyclodialysis was done in the left eye on November 12, 1957. DFP was used, beginning with the first postoperative day, and the tension was maintained at about 25 mm. Hg. On May 13, 1958, after having discontinued DFP for three days, the tension went up to 40 mm. Hg in the left eye. The cleft could not be found on gonioscopic examination. DFP was instilled while the patient was in the clinic; one hour later the tension was 18 mm. Hg and the cleft was visible. This clinical observation was confirmed on several occasions.

Most of the eyes which responded favorably to DFP after cyclodialysis had failed to respond to the same medication before cyclodialysis. DFP after cyclodialysis causes no discomfort in aphakic eyes and only little discomfort in phakic eyes. The only contraindication to the use of DFP is the presence of active iridocyclitis. It should be remembered, however, that a flare may appear in the aqueous as a result of the use of this agent. Some cases require the continued use of DFP for an indefinite period in order to keep the cleft patent and maintain tension at a normal level.

Indications for cyclodialysis

Although the postoperative use of DFP adds to the success of cyclodialysis, it is, nevertheless, important to follow definite criteria in the selection of cases. Cyclodialysis is indicated in eyes in which the cleft can be kept patent permanently, namely in eyes with deep chambers and wide angles. It is indicated in the following types of glaucoma:

1. *Glaucoma in aphakic eyes,* in which extensive anterior peripheral synechias result either from delay in reformation of the anterior chamber or from postoperative iridocyclitis. Cases of this type, when detected early, can often be controlled with strong miotics, such as pilocarpine (four percent) solution and DFP ointment. When miotics are ineffectual, cyclodialysis is the only safe operation. External fistulizing operations in aphakic eyes may be followed by loss of vitreous and retinal detachment. In this type of glaucoma, cyclodialysis detaches the anterior peripheral synechias and frees the trabecular meshwork, thus restoring the normal route of outflow. In addition, the operation also provides drainage through the cleft into the suprachoroidal space. These two effects of the operation can be verified gonioscopically.

2. *Chronic simple glaucoma.* Cyclodialysis should be done only in eyes with wide and intermediate angles, that is, when the ciliary body or at least the scleral spur is visible gonioscopically. In eyes with narrow angles, the approach to the cleft may easily become blocked by anterior peripheral synechias, especially in the presence of postoperative iritis.

Very advanced cases of chronic simple glaucoma are not suitable for cyclodialysis for several reasons. In an eye with a very restricted field and central vision reduced to 20/30 or lower as a result of the glaucoma, postoperative hypotony may cause loss of both the remaining field and the central vision. In this respect cyclodialysis is as dangerous as external fistulizing operations.

In addition, cyclodialysis is not effective in advanced chronic simple glaucoma. Such eyes have a thinned and atrophic choroid of poor absorptive capacity and aqueous is not

adequately absorbed in the suprachoroidal space. Even if one were to succeed in stripping the canal of Schlemm, the tension most likely would not be controlled because, in advanced cases, fibrosis of the outflow channels involves not only the trabecular meshwork but also the canal of Schelmm and the external collector channels.

Cyclodialysis should be reserved mainly for early or slightly advanced, medically uncontrolled, chronic simple glaucoma. In more advanced cases, cyclodialysis may be tried if central vision is still 20/20 and the field extends to five to eight degrees concentrically around the fixation point.

3. *Chronic noncongestive angle-closure glaucoma.* In the advanced stage of this type of glaucoma, the greater part of the angle circumference is closed. An iridectomy may not re-open the angle sufficiently because of firm adhesions between the iris and the anterior wall. In such eyes there is usually residual glaucoma after iridectomy; cyclodialysis is therefore indicated in order to supply an additional route of drainage. After the iridectomy, the anterior chamber becomes deeper and the entrance to the angle wider. This improves the chances for a successful cyclodialysis.

Cyclodialysis may also be combined with iridectomy in one operation through two separate incisions, as advocated by Posner.[6] Cyclodialysis, either following or in combination with iridectomy, is a safer operation than an external fistulizing operation for several reasons:

1. There is less danger of malignant glaucoma.

2. After external fistulizing operations, additional anterior peripheral synechias form as a result of a flat chamber in the immediate postoperative period. This causes closure of the remaining open portions of the angle. If external filtration stops, as it often does, one is faced with a hopeless situation. This complication seldom occurs after cyclodialysis following or combined with iridectomy.

3. Cataract, although almost as frequent after cyclodialysis as after external fistulizing operations, is easier to handle after iridectomy and cyclodialysis.

Summary and Conclusions

1. Cyclodialysis lowers ocular tension by establishing drainage of aqueous through the cleft into the suprachoroidal space.

2. In addition to the cleft, in some cases, cyclodialysis also provides a direct communication between the anterior chamber and the canal of Schlemm.

3. DFP helps to maintain patency of the cleft, probably by contracting the ciliary muscle.

4. Cyclodialysis is useful not only in aphakic glaucoma but also in chronic simple glaucoma with wide angle, and in noncongestive angle-closure glaucoma, following or combined with iridectomy.

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AGAR MICRO-ELECTROPHORESIS OF HUMAN TEARS*

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Tears contain a relatively large quantity of protein, which shows considerable individual variations. In 30 normal subjects Junnola (1952)—using the nephelometric method—found values from 136 to 592 mg./100 ml., with an average of 360 mg./100 ml. The concentration was found to be lower in aged subjects than in the young.

Considerable progress has been made in the study of tear proteins since it has become possible to study the separate fractions with the aid of electrophoresis. Using the so-called free electrophoresis technique of Tiselius, four fractions were distinguished by Smollens, Leopold, and Parker (1949). Using the same technique (Spinco apparatus, model H), Brunish (1957) demonstrated the presence of an albumin, three globulins and a lysozyme fraction.

Since the quantity of tears available is small, the majority of authors resorted to paper electrophoresis and obtained comparable results. They were Caselli and Schumacker (1954), McEwen and Kimura (1955), Erickson, Feeney and McEwen (1956), McEwen, Kimura and Feeney (1958), Erickson, Hatlen, and Berg (1958, 1959).

The most rapidly migrating fraction—albumin—has a mobility which is slightly superior to that of the albumin in human serum (Brunish, 1957).

In the globulin group, three fractions are distinguished, the mobility of which corresponds with α_2-globulin, β-globulin and γ-globulin (Brunish, 1957).

The fraction which corresponds to the lysozyme migrates toward the cathode, when the pH is neutral or slightly alkaline. The lysozyme, which has been isolated and crystallized from egg white (Abraham and Robinson, 1937), is in fact one of the most basic proteins known. Its iso-electrical point is between pH 10.5 and pH 11.0 (Alderton, Ward, and Fewold, 1945).

Brunish (1957) has demonstrated that there are not only individual variations in the mobility of the lysozyme but also periodic variations in the same subject. He distinguishes two varieties which are never found together.

The clinical significance of changes in the protein composition of tears has been well demonstrated by Erickson, Hatlen, and Berg (1958, 1959). These changes are particularly important in cases of conjunctivitis sicca and in conjunctival irritation.

We have studied tear proteins with the aid of agar micro-electrophoresis, obtaining results which were highly different from those yielded by paper electrophoresis.

Technique

With the aid of a capillary pipette, a few ml. of tears are drawn in from the conjunctival sac, avoiding as much as possible irritating the eyeball.

Paper electrophoresis is effected in a veronal buffer solution (pH 8.6, ionic strength 0.1).

If we use the technique of agar micro-electrophoresis (Wieme and Rabaey, 1957; François and Rabaey, 1958), then 1.0 to 2.0 ml. of previously concentrated tears is sufficient to obtain quantitative findings. Fractionation of proteins is carried out in a one-percent Difco Noble agar: veronal buffer solution at pH 8.4; ionic strength 0.05; constant temperature 10°C.; potential gradient of electric field 10 v./cm. for 25 minutes.

The mobility of the fractions is a relatively mobility as compared with that of human serum albumin, the mobility of which is considered to equal +1; the zero point is indicated by dextran.

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TABLE 1

RATIO OF THE VARIOUS PROTEIN FRACTIONS IN TEARS BY PAPER ELECTROPHORESIS

	Percent of fractions
Albumin	20.2
Globulins	56.9
Lysozyme	22.9

TABLE 2

RATIO OF THE VARIOUS PROTEIN FRACTIONS IN TEARS BY AGAR MICRO-ELECTROPHORESIS

Relative Mobility	Percent of Fractions
1.24	1.8
1.17	6.9
1.13	5.5
1.05	17.1
Fraction L: 0.97 · · · 0.59 (max. at 0.86)	64.6
0.59 · · · 0 (max. at 0.34)	1.4

The lysozyme activity is verified with the aid of Micrococcus lysodeicticus. Before fixation of the pherogram, portions of the agar are excised and incubated in a suspension of Micrococcus (0.5-percent NaCl solution); the lysis of the bacteria is then controlled.

RESULTS

Agar micro-electrophoresis has two important advantages: (1) the quantity of solution required is minimal and (2) protein fractionation is much more detailed than that with other techniques. It is for these reasons that we considered it interesting to use agar micro-electrophoresis in investigating tear proteins

The figures and tables presented show that paper electrophoresis and agar micro-electrophoresis of tears from normal subjects yield highly diverse results.

After paper electrophoresis (fig. 1), a rapid fraction is seen to move toward the anode (albumin); slower fractions also move toward the anode (globulins) and there is a fraction which moves toward the cathode (lysozyme) (table 1).

After agar micro-electrophoresis (figs. 2 and 3) we obtain four fractions in which the relative mobility exceeds that of human serum albumin, and a fraction L (lysozyme), which moves toward the anode rather than toward the cathode. There are no important fractions corresponding to the globulins (table 2).

With regard to albumin it must be pointed out that both paper electrophoresis and free electrophoresis yield only one protein fraction, the mobility of which is higher than that of human serum albumin. Agar micro-electrophoresis constantly yields three to four fractions which have this characteristic and which, together, represent almost 30 percent of the soluble proteins in tears, namely, an important fraction with a relative mobility of 1.05, one or two less marked

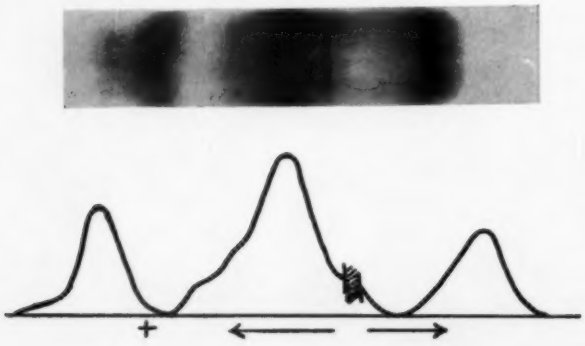

Fig. 1 (François and Rabaey). (Above) Paper pherogram of human tear proteins. (Below) Corresponding diagram.

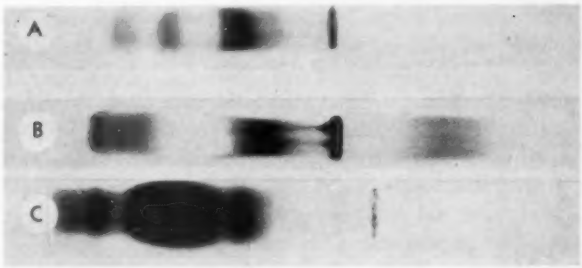

Fig. 2 (François and Rabaey). Agar microelectrophoresis of tear proteins. (A) Normal individual. (B) Individual with abnormal proteins fractions. (C) Rabbit.

fractions with a relative mobility of 1.13 and 1.17, and a more rapid fraction with a relative mobility of 1.24.

With regard to the lysozyme, one might expect to find it on the side of the cathode, reckoned from the zero point indicated by dextran; yet in no pherogram did we find a fraction on that side.

In order to establish whether a fraction possesses enzymatic activity and which fraction, we excised portions of agar before fixation of the pherogram (fig. 4), incubating them in a suspension of Micrococcus lysodeicticus. Lysis of this bacterial suspension was seen with the Samples 3, 4, and 5. There was, therefore, enzymatic activity localized at the line of departure and throughout the zone corresponding with fraction L (relative mobility 0.59 to 0.97).

This fraction is very wide and presents a frayed outline resulting from partial progressive precipitation of the protein in contact with the agar.

These findings show that the lysozyme does not migrate normally in the agar. Due to an interaction between the enzyme and the agar, the mobility of the protein molecules is changed in such a way that they migrate toward the anode. The lysozyme is gradually precipitated in the process.

The interaction, meanwhile, does not give rise to complete inactivation; after electrophoresis and elution some important enzymatic activity persists.

The interaction is even more evident when a pure lysozyme is used, isolated from egg white. During its introduction into the agar, the enzyme is completely precipitated at the site where it is deposited; this finding—whether isolated or associated with that of other lacrimal proteins—is not surprising,

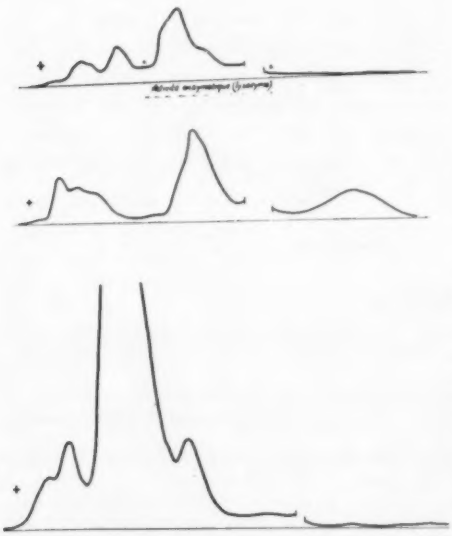

Fig. 3 (François and Rabaey). (Above) Diagram corresponding to Figure 2-A. (Center) Diagram corresponding to Figure 2-B. (Below) Diagram corresponding to Figure 2-C.

Fig. 4 (François and Rabaey). Excision of portions in an agar pherogram of human tear proteins.

as this enzyme normally attacks the mucoproteins and glucoproteins of the bacterial walls.

The fact that the fraction L, migrating toward the anode, does correspond to the lysozyme, is demonstrated also by examination of rabbit tears which do not contain this enzyme and yield no slow fraction by paper electrophoresis (Erickson, Feeney, and McEwen, 1956). Agar micro-electrophoresis (fig. 2-C) of these tears also fails to show a frayed and precipitated L-fraction.

This anomalous behavior of the lysozyme constitutes an obvious handicap in the clinical use of agar micro-electrophoresis. The important feature, meanwhile, is determination of the quantity of lysozyme in the tears, since this enzyme has both an antibacterial and an antiviral effect and since it diminishes in some pathologic conditions such as conjunctivitis sicca.

With regard to the globulins which are obtained by paper electrophoresis, they are not or hardly obtained by agar micro-electrophoresis. It is possible (although not really probable) that, under these conditions, part of them migrate to the zone corresponding to the lysozyme.

It is likewise possible that, in agar, the mobility of some globulins increases so as to exceed that of serum albumin. It also may be that some globulins are precipitated in the agar, binding themselves to the basic lysozyme. However this may be, it was only in one case that we found a significant quantity (23 percent) of a protein fraction with a relative mobility of about 0.35, that is between that of the β-globulin and that of the γ-globulin fraction (fig. 2-B).

The various fractions in this particular case were divided as follows:

1. Fractions with a mobility exceeding that of serum albumin: 1.3, 8.4, 8.2, and 9.9 percent.
2. Lysozyme: 48.8 percent.
3. Slow fraction (relative mobility 0.35): 23.4 percent.

Although agar micro-electrophoresis of tears is not convenient in clinical investigation (at least when used alone), it may nevertheless offer interesting information on the protein composition of tears in general and on their enzymatic activity in particular.

Summary

Paper electrophoresis of tears shows three important protein fractions, albumin, globulins, and lysozyme. Agar micro-electrophoresis gives very different results, showing four fractions in which the mobility exceeds that of serum albumin and one fraction which corresponds to lysozyme, with an inverted direction of migration. In normal tears there are no important fractions corresponding to the globulins.

De Pintelaan.

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CLINICAL INVESTIGATION OF CORALOX† FOR THE TREATMENT OF GLAUCOMA*

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Studies on the toxicology and pharmacology of coralox on ocular instillation were reported in previous communications. DuBois, Schmalgemeier and Plzak studied the pharmacology and toxicology of this compound and reported that its toxicity was within the range of that exhibited by DFP, TEPP and Mintacol: 2.6 mg./kg. intravenously and 8.0 mg./kg. orally. It is a potent anticholinesterase agent, and is capable of passing the blood-brain barrier, as well as the blood-aqueous barrier, as shown by its ability to inhibit cholinesterase in the brain, ileum, blood, salivary gland, iris and ciliary body, and retina of rabbits, and in the brain of rats, mice, guinea pigs and rabbits on injection, ingestion or ocular instillation. It is capable of producing some cholinesterase activity in the aqueous humor of rabbit eyes on direct instillation or by systemic absorption. It was found that eyedrops instilled into the eyes of rabbits could be found in the lungs and bronchi of rabbits.

In the rabbit, miosis is produced maximally for four hours, with some miotic effect lasting up to eight hours. In the dog, miosis lasts up to 15 hours. In cats, there is no miotic effect. In humans, miosis and ciliary spasm persist for more than 15 hours, so that a species variation exists, such that miotic activity of coralox is much greater in dogs and humans.

Coralox did not produce chemical irritation in the eyes of rabbits after use for periods up to 30 days, and while some conjunctival injection was noted when the drug was first used, this disappeared, and in humans was not found in periods of treatment lasting more than nine months. No patient has found it necessary to discontinue the drug because of chemical irritation or congestion.

EFFECTS ON INTRAOCULAR PRESSURE

The purpose of anticholinesterase administration is to reduce intraocular pressure. For many decades physostigmine has been employed to obtain this effect. However, it has been known for a long time that eserine or physostigmine (Wessely,[1] 1913) and neostigmine (Kull,[2] 1942), when instilled in the eye, usually produce a slight, though transient, increase in the intraocular pressure. A similar effect is seen still more clearly after polyalkylphosphates both in test animals (von Sallmann and Dillon,[3] 1947) and in humans (Scholz,[4] 1946). As a result of contralateral pupillary dilatation, increased pressure may

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† Oxygen analogue of Co-Ral.

also be seen in the untreated eye (Linn and Tomarelli,[5] 1952). Evidence of the part played by vasodilatation in the increase in tension is also supplied by the findings of Bietti[6] (1954) regarding the effect of nicotine and acetylcholine in provocative tests for glaucoma.

Dunphy[7] (1949) found a permanent increase in pressure with anticholinesterase agents, with physostigmine, but numerous other cases have been observed after organic phosphates also. Cases of congestive and narrow-angle glaucoma especially have a tendency to react with increased pressure, probably due to changes in the blood-aqueous barrier by the action of these drugs.

Generally, these chemicals reduce the intraocular pressure. The polyalkylphosphates have a stronger action than substances earlier employed. Phospholine Iodide[13] is a chemical combination of alkylphosphate with quaternary amine, which has been found to have great miotic potency, and which is water soluble, stable and lasts up to three weeks. Demecarium bromide[14] is a quaternary compound which has marked anticholinesterase activity, is water soluble, stable and its action may last two weeks. Di-isopropyl-fluorophosphate (DFP) has been extensively investigated, and has been used as a tool in pharmacologic studies because of its "irreversibility." Grant[8] (1950) studied TEPP (tetra-ethyl pyrophosphate) for its miotic activity, but did not find it superior to physostigmine (Marr and Grob,[9] 1950). Mintacol produces no significant decrease in pressure in healthy eyes, but has frequently proved valuable in the treatment of glaucoma, and is more extensively used in Europe.

The degree of miosis was found to have no correlation with changes in blood vessel or ciliary epithelium permeability by Swan and Hart[10] (1940); Stone[11] (1950) found no correlation to fall in pressure. Pressure can be reduced with no miosis in eyes with iridectomy (Leopold and Comroe,[12] 1946). Dunphy[7] found that vasodilatation tends to increase the iris volume, and cyclotonia, and thus causes the lens to push the iris root forward, compressing the chamber angle.

Potency relations are not available because of lack of uniform and systematic tests. Linn and Tomarelli[5] (1952) reported that onset of miosis is equally rapid after eserine, DFP and TEPP, and slower after neostigmine and stigminene. Duration of activity would list these compounds on diminishing potency: phospholine, demecarium, DFP, TEPP, and eserine. Pressure reduction is probably greatest with phospholine and demecarium bromide, with neostigmine, TEPP, DFP, following; eserine raised pressure. In general, eserine was found to be weaker than TEPP, but according to Kull[2] (1942), lasts longer. Mintacol has been regarded as equal or better than eserine and pilocarpine.

Coralox is soluble in peanut oil, and is used in solutions of 0.25 percent. It has very little solubility in water. The peanut oil solution is stable, and must be heated to disperse the coralox powder, which does not again separate out from the oil combination.

The patients selected for trial with coralox (37 eyes) had all been found to be unsuccessfully controlled with pilocarpine, eserine and Diamox, and had abnormal intraocular pressures on treatment. These were primarily cases of primary wide-angle glaucoma, with some cases of aphakic and secondary glaucoma. Coralox was found to be of value in lowering tension in these eyes to levels lower than previously attained with other drugs used. No change in the mathematical value for coefficient of outflow was found with coralox from the other compounds used, and coralox did not alter the coefficient. It did not lower the facility of outflow in normal eyes, in seven patients tested after one hour. Criteria for control consisted of: (1) No loss of vision or field; (2) tension-lowering below a reading of 4.5 with 5.5-gm. weight (Schiøtz) or in blind eyes lowering to relative normal values.

Coralox was found to be useful for nighttime therapy in narrow-angle glaucoma, in combination with day-time instillation of

TABLE 1

GLAUCOMA PATIENTS TREATED WITH CORALOX EYEDROPS (0.25 PERCENT THREE TIMES A DAY)

Age (yr.)	Sex	Previous Treatment Pilocarpine (percent)	Control Tension (mm. Hg)	Tension on Coralox Average of Readings (mm. Hg)	Facility of Outflow		Weeks of Treatment	Complications
					Pilocarpine	Coralox		
GROUP I. GLAUCOMA: CHRONIC SIMPLE								
48	F	4	25.5 25.5	22.0 22.0	0.10 0.10	0.14 0.185	36	None
60	M	4	22.0 38.0	22.0 38.0	0.18 0.05	0.18 0.10	12	Returned to pilocarpine
50	F	4	37.0 35.0	35.0 35.0	0.05 0.05	0.05 0.05	12	Surgery
67	M	4	25.0 25.0	18.0 16.0	0.07 0.10	0.07 0.12	36	Surgery left eye
58	F	2	20.0 20.0	15.0 17.0	Refused		16	Blind
74	M	4	32.0 37.0	35.0 35.0	0.08 0.06	0.08 0.08	12	Iridencleisis cyclodiathermy
44	F	4	37.0 31.0	22.0 18.0	0.12 0.16	0.18 0.15	20	None
45	F	4 (plus Carcholin)	30.0 35.0	20.0 20.0	0.15 0.11	0.16 0.11	16	None; with acetazolamide
48	F	4	42.0 23.0	22.0 20.0	0.18 0.19	0.19 0.19	18	None
38	F	2	17.0 18.0	18.0 18.0	0.16 0.15	0.15 0.15	8	Blurring, ciliary spasm
54	M	None	26.0 26.0	23.0 23.0	0.10 0.14	0.10 0.16	48	Blurring lasting 15 hr.
GROUP II. SECONDARY GLAUCOMA OR APHAKIC GLAUCOMA								
65	M	4	61.0	23.0	0.04	0.04	36	None; traumatic (?) cataract
67	F	4	49.0	30.0	Left hospital		36	Diabetic with blind eye
64	F	4	31.0	22.0	0.06	0.06	36	Secondary glaucoma cataract surgery
57	F	4 (plus Carcholin)	23.0 27.0	20.0 25.0	Refused		32	Iridencleisis; cataract surgery
59	F	4	43.0	30.0	Refused		32	Blind eye, cataract surgery
18	M	2	24.0	18.0	Refused		16	Secondary glaucoma, traumatic
60	M	None	28.0	20.0	0.12	0.18	16	Aphakic glaucoma
GROUP III. ANGLE-CLOSURE GLAUCOMA (Coralox used only as night-time drop medication)								
80	F	4 (plus eserine nightly)	42.0 23.0	21.0 19.0	0.12 0.12	Refused	12	Senility, unco-operative
58	F	2	24.0	20.0	0.28	0.28	28	Acute attack prior to coralox treatment
72	M	2	26.0 26.0	21.0 22.0	0.18 0.19		32	Does not keep appointments

pilocarpine, and was used to replace eserine ointment. It was found to be useful in combination with carbonic anhydrase inhibitors such as Diamox and Daranide. Its main use was found to be in aphakic and secondary glaucoma, and in primary wide-angle glaucoma.

This compound suffers all the physiopathologic disadvantages of other anticholinesterase drugs which act on the outflow mechanism and are therefore dependent on the amount of structural deterioration in the chamber angle. Four patients in the small series were subjected to surgery when it was found that drug therapy was inadequate to control the tension. Very low levels of facility of outflow characterized these cases. Iridencleisis or cyclodiathermy were employed. Three other patients in this series were given other management when coralox failed to lower tension beyond that already achieved. Thus, 15 patients diagnosed as having aphakic glaucoma, secondary glaucoma or primary wide-angle glaucoma were successfully maintained at normal tension levels for as long as nine months.

Toxicity was manifested only by the finding of inhibition of serum cholinesterase activity to very low values (zero). Red blood cell cholinesterase activity was not altered. No subjective or objective observations of malaise or disease were noted. Browache and ciliary spasm occurred in only three cases. In two patients, both presbyopes-hyperopes, it was found that they could read without glasses as long as 15 hours after instillation of coralox.

Coralox has been found to be a useful agent for lowering intraocular pressure in glaucoma in humans.

Krishna and Leopold suggested that the criteria for an ideal anticholinesterase agent or cholinesterase inhibitor from the point of view of an ophthalmologist would include the following:

1. An ideal agent would be one which when applied locally would bring about control of intraocular pressure without disturbing the physiology of the rest of the body, and be free from both systemic and local side-effects.

2. It may be used in conjunction with other agents and thus potentiate the action of the other, if either alone fails to bring about control of intraocular pressure.

3. Since primary glaucoma is a life-long malady, an agent which is long-acting in its duration of action would be a distinct advantage. For the same reason it should be effective in least concentrations and frequencies of administration.

4. It should be easily stored for longer periods and not deteriorate under ordinary conditions, and be *water* soluble.

On the basis of the above criteria, coralox has been shown to be a potent anticholinesterase agent, which is oil soluble and stable, used in 0.25-percent solutions, and has a period of action lasting at least 15 hours in humans, with a level of toxicity and side-reactions that compares favorably with presently used and newly introduced drugs for the same purpose. It is readily reversed, and may be used in combinations of therapy to produce potentiation and synergism.

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INVESTIGATION OF ACID MUCOPOLYSACCHARIDE IN FETAL CHAMBER ANGLES*

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Ocular mucopolysaccharides have been the subject of much recent investigation and there has been widespread interest and speculation as to their function within the eye. In general, mucopolysaccharides are hexosamines and contain a polysaccharide which occurs either free or loosely combined with protein.

In 1934, Meyer and Palmer[1] while working with vitreous from cattle eyes, prepared an extract of an acid polysaccharide and proposed the name of hyaluronic acid from hyaloid (vitreous) and uronic acid. At that time they first speculated a possible connection between the acid polysaccharide and the problem of glaucoma. When later Meyer and Palmer[2] first demonstrated the presence of hyaluronic acid in the aqueous, they believed it to be identical to the hyaluronic acid of the vitreous. At that time it was suggested that the ciliary epithelium was the source of this material and that it would prove to be of great importance in controlling the water balance of the intraocular fluid under normal and pathologic conditions.

Hyaluronic acid[3] in animal tissues seems to bind water in the interstitial spaces and holds cells together in a jellylike matrix. In addition it serves as a lubricant and shock-absorber in joints. It is desaggragated and depolymerized by the action of the enzyme hyaluronidase to acetyl glucosamine and glycuronic acid. It is a component of the capsules of certain strains of pneumococci and streptococci and is also found in the synovial fluid and the umbilical cord. Hyaluronidase, by destroying hyaluronic acid, reduces viscosity and permits greater spreading of materials in the tissue spaces.

Ashton[4] in an exhaustive review of the histology of the uveoscleral trabecular meshwork used toluidine blue and was able to demonstrate metachromasia in the area and noted that no metachromasia could be found in any section which had been previously treated with hyaluronidase. Vrabec[5] continued this line of investigation and, by embedding sheep eyes in Celodal and staining with cresyl violet, found the layers between

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the trabeculae to be filled with an amorphous material. He found the highest concentration of this material at the tip of the trabecular meshwork close to the cornea and the next highest concentration in the external spaces of the meshwork close to the inner surface of the sclera.

Brini,[6] while working with freshly enucleated human eyes, histologically demonstrated mucopolysaccharides in the trabeculae of human eyes, as evidenced by such staining procedures as periodic acid-fuchsin, alcian blue, or metachromasia with toluidine blue. Following treatment with hyaluronidase, he noted no change in staining with periodic acid-fucasin but metachromasia and alcian blue staining were altered.

By perfusing enucleated human eyes with hyaluronidase and adding a radiocontrast substance, François[7] showed microradiographic evidence of enlargement of the trabecular clefts and their orifices into Schlemm's canal and from his studies concluded that this demonstrated an increased permeability of the connective tissue building up the trabeculae.

At the First Conference on Glaucoma, Bárány[8] showed that, in cattle eyes perfused with hyaluronidase, a marked decrease in resistance to aqueous outflow occurred. Similar findings were found by François[9] in human eyes in which there was a 25 to 30 percent decrease in resistance. These findings introduced a new concept that the trabeculae should be regarded as being a structure with a complex physiology of its own and not a simple mechanical drainage structure. The permeability of this area could be directly or indirectly related to physiochemical changes in the aqueous.

In 1957, Zimmerman[10] presented photographic evidence of a hyaluronidase-sensitive acid mucopolysaccharide in the trabecular area of routinely sectioned human eyes. He called attention to the fact that most of the acid mucopolysaccharide appeared to be near the inner wall of Schlemm's canal and that a large amount was found in the uveal tissue of the angle anterior to the ciliary muscle and also in the iris stroma. He again suggested the relationship of this substance to the etiology of glaucoma.

At present the source of the trabecular acid mucopolysaccharide is unknown but there are two theories as to its source:

1. The endothelial cells covering the trabecular fibers may secrete the acid mucopolysaccharide since it is believed that mucopolysaccharides of ground substance are derived from endothelial cells.

2. That acid mucopolysaccharide is derived from the aqueous since this is known to contain hyaluronic acid and that these large molecules of highly polymerized mucopolysaccharides are filtered out of the aqueous by the trabeculae.

Investigation by Gemolotto and Petrone[11] into the mucopolysaccharide content in human cornea and sclera showed that the greatest amount was present in persons between the ages of 20 and 40 years. Zimmerman,[12] in a recent study of developing mouse eyes, at birth found faint staining of the cornea with virtually no staining of the sclera. The sensory retina, optic nerve, or vitreous did not stain with alcian blue, but on the ninth day of life, diffuse staining of the vitreous occurred. In this article there is no mention as to the staining reactions of the trabecular meshwork of these mouse eyes.

Talman and Harris,[13] however, pointed out the hazards of applying any physiologic significance to histologic staining with dyes which presumably identify acid mucopolysaccharides. They noted that the techniques not only are not specific for mucopolysaccharides but that many of the compounds which give the same positive stain because of their similar chemical properties often possess very different biologic activities.

Since there has not to date been an evaluation of the staining properties of human fetal eyes for acid mucopolysaccharides, we felt that such a study was important, par-

ticularly in relation to the staining reaction of the trabecular meshwork.

Materials and Methods

A total of 27 fetal eyes were studied, the specimens being from one month of gestation to full-term. The eyes were fixed in 10-percent formalin and serial paraffin sections were stained with the Rhinehart-Abul-Haj modification of the Hale procedure.[14] With this procedure the acid mucopolysaccharides turn bright blue due to the Prussian blue reaction. The picrofuchsin counterstain stains collagen red, smooth muscle yellow green, elastic tissue orange and nuclear chromatin gray brown.

One section from each eye was treated with bovine testicular hyaluronidase (Wydase),[15] prior to staining, and the adjacent section was stained without prior exposure to hyaluronidase. As a control, a normal adult eye was included in each series to demonstrate the presence of the acid mucopolysaccharide and to insure effectiveness of the stain as well as the activity of the hyaluronidase.

Results

In the one-month specimens the primary vitreous shows very marked staining for acid mucopolysaccharide and this material is hyaluronidase sensitive. However, at this stage there is no staining of the primitive retinal elements. At three months the intense blue staining becomes less, as the primary vitreous is being replaced by the secondary vitreous, but the secondary vitreous continues to show acid mucopolysaccharide until term. Even though the rods and cones begin to develop about three months, no staining is present at this time but at four months the fiber layers of the retina show evidence of acid mucopolysaccharide. The developing choriocapillaris at this stage also shows evidence of hyaluronidase-sensitive acid mucopolysaccharide.

The six-month specimens show evidence of some acid mucopolysaccharide in the rods and cones for the first time. None can be demonstrated in the choroid now but there is extracellular acid mucopolysaccharide present in the iris. When the acid mucopolysaccharide makes its appearance in the rod and cone layer, the acid mucopolysaccharide in the fiber layers has disappeared.

The chamber angle is differentiated by seven months but no extracellular acid mucopolysaccharide can be seen in the trabecular meshwork. The secondary vitreous, iris stroma, and rods and cones show staining for acid mucopolysaccharide even though none is present in the chamber itself. No extracellular acid mucopolysaccharide can ever be seen in the trabecular meshwork from the time the cleavage first starts until the angle is completed. In addition, no extracellular acid mucopolysaccharide can be seen in the chamber angle of full-term eyes.

Wirtschafter and others,[16] who have done much work with acid mucopolysaccharide, have demonstrated the relationship of intracellular acid mucopolysaccharide to fibroblastic proliferation and disappearance of the acid mucopolysaccharide when the active proliferation is over. The appearance and disappearance of the intracellular acid mucopolysaccharide during various stages of maturation of the fetal eyes could certainly be related to active fibroblastic proliferation in the developing eye.

Summary

Twenty-seven fetal eyes, representing each month of gestation from one month until term, were stained with the Rhinehart-Abul-Haj modification of the Hale procedure for the presence of acid mucopolysaccharide as well as sensitivity to bovine testicular hyaluronidase.

Acid mucopolysaccharide could be demonstrated in various ocular tissues during maturation but at no time could any extracellular acid mucopolysaccharide be demonstrated in the trabecular meshwork.

919 Taylor Street Building (5).

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Ophthalmic Miniature

The first instance of glaucoma treated by excision of a portion of iris by von Graefe's method, was, in a case of chronic glaucoma, operated upon May 1st, 1857; a second case was treated in the same manner in October in the same year. Both were cases of chronic glaucoma in an advanced stage, and their immediate result for vision was not such as would recommend the operation. Then came several cases of acute and subacute glaucoma, in which a striking improvement followed shortly after the operation.

Dr. Bader,
Royal London Ophth. Hosp. Reports, **2**:168, 1859-1860.

NOTES, CASES, INSTRUMENTS

BIOMICROSCOPY OF THE FUNDUS*

WITH A CORNEAL CONTACT LENS

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Slitlamp biomicroscopy of the vitreous and fundus is essential in diseases of the retina and is of special value in retinal detachment work. However, mastery of such an examination requires considerable practice and experience with the presently available instruments.

The Koeppe contact lens and its various modifications, including the Goldmann fundus contact glass and three-mirror lens,[1] as well as different gonioscopic lenses, have well-known advantages. They are mostly of the scleral contact-lens type and are, therefore, relatively large and heavy and must be held in position most of the time.

The co-ordination required to center the lens on the optic axis of the observation system becomes increasingly more difficult as an attempt is made to view farther into the periphery of the fundus. Usually only a small area around the posterior pole can be seen. Goldmann incorporates three mirrors in his lens in order to see beyond an area of 30 degrees from the disc; thus the peripheral retina can be viewed but with a number of disadvantages.

The value of the −55D. preset lens is best demonstrated in the superb illustrations of Hruby's *Atlas*.[2] The +55D. lens[3] held in front of the patient's eye is a form of indirect ophthalmoscopy which has certain inherent advantages. However, the student of these methods must keep in mind that when using either of these lenses they become a part of a composite optical system, and the smallest movement results in a change of focus and decentration. The field of view with the Hruby lens is even smaller than with a Koeppe lens.

It appeared desirable to improve the present methods of fundus biomicroscopy so an attempt was made to obtain a simplified and improved optical system with a better centration on the common optic axis. An improved instrument should provide a larger field, make possible examination of the periphery, increase stereopsis, and give a clearer view of the fundus and slitlamp beam. The instrument should also be easy to handle and use and should not have to be held in position by the examiner. A corneal contact lens meets these requirements.

DESCRIPTION OF THE LENS

This corneal contact lens is made of plexiglass, with a base curve and a peripheral second curve, a diameter slightly smaller than the average cornea, and a peripheral thickness of about 2.5 mm. The front surface has an almost flat optical zone of nine to 10 mm. The weight is less than 0.2 gm. The relationship between the base curve, the size, and the bevel is chosen to create a lens which will have a somewhat tight fit on the average cornea but one that fits most patients.

PROPERTIES OF THE LENS

The lens rests on the corneal tear layer and moves sufficiently to allow good tear flow and aeration but not to such an extent that the optics are disturbed. It can be left on for a long period of time without ill effects—an important factor when making a fundus sketch. Lowering of the upper lid associated with downward gaze in examining the lower fundus periphery, as well as blinking, is prevented by the peripheral thickness, yet the patient can voluntarily close his lids over the lens. If displacement occurs, it is corrected in almost all instances by self-centration of the lens. Once it is in place, the examination can be made without any further manipulation of the lens and the observer has his hands free.

Improved physiologic optics are obtained

* The lens described in this paper may be obtained from Doctors Contact Lens Service, Inc., 3971 Wilshire Boulevard, Los Angeles 5, California.

by the good fit of the lens on the average eye, which eliminates all corneal astigmatism. An important factor is the good centration, which facilitates the co-ordination of all components of the system upon a common optic axis.

Another advantage is that the lens is thin, thus the new refracting surface of the patient's eye is much closer to the pupil, which acts as a field stop. This in turn brings the coupled slitlamp system somewhat closer to the eye and allows an increase in the angle between the illumination and observation systems. An increase of this angle improves the resolving power of the slitimage as to depth, as was pointed out by Rotter.[4]

When the patient rotates his eye, the lens lags slightly to the opposite side. This is helpful in observation of the periphery. The posterior surface of the lens is kept clear by the tear fluid, while scratches or reflexes of the anterior lens surface do not interfere with a good view.

The fundus can be examined through an undilated pupil. The area seen in one field of view increases with hypermetropia, lower magnification, and mainly with pupillary dilation. The field of vision is considerably larger than with the Hruby lens and somewhat larger than with most Koeppe-type lenses.

An advantage of the new lens is that the examiner can scan a large area of the fundus, utilizing the large optical zone provided and taking full advantage of the amount of dilation, merely by control of the coupled slitlamp system. To look further into the periphery, either the patient's eye or the biomicroscope must be rotated.

Within a widely dilated pupil, an area beyond the equator is visible sometimes. The fundus image is clear and erect and very little or no distortion occurs in the periphery. Since the lens rests only on the cornea, scleral depression can be used. Ophthalmodynamometry also can be performed and a more accurate end-point obtained.

The magnification without using a microscope is minimal but can be increased to any amount, depending upon the power of the microscope. A 40-times magnification does not require any special skills, and slight movements of the patient's eye are readily corrected with the "joy stick."

The slitimage is sharply outlined on the areas under examination. This and the increased angle between the illumination and observation systems made possible with this lens allow the inner and outer limiting layers of a "retinal block" to be seen with remarkable clarity and ease. The slitbeam of a modern instrument can be changed and directed from right to left during the analysis of an area, without obscuring the view at any time.

Stereopsis is immediately realized and is most impressive. The fundus appears concave and structures in the vitreous, retina, and optic nervehead are seen in three dimensions without difficulty. The depth of field is excellent, allowing fairly anterior vitreous opacities and the retina to be viewed simultaneously.

Insertion and removal

Various methods for the insertion and removal of this lens can be used. They are the same as with any other corneal contact lens, except that surface anesthesia is employed in most cases. One such procedure is outlined:

The patient is instructed to look down, the lid is elevated, and the lens, which has been moistened with water or saline, is placed on the sclera and upper part of the cornea. While releasing the upper lid, the patient looks straight ahead and the lens self-centers on the cornea. It remains in place due to capillary attraction, which if insufficient, can be increased by slight pressure of the lens against the eye.

Removal is performed in a conventional manner: The patient is instructed to open his eyes widely; as he blinks, lateral pull is exerted at the outer canthus and the lens is forced out. Another convenient method of insertion and removal is with a suction holder.

14401 Hamlin Street.
419 North Newport Boulevard.

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SCLERAL PERFORATION DURING STRABISMUS SURGERY*

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Although we welcome advances in instrumentation, they sometimes create unexpected hazards. The exquisitely sharp new surgical needles permit precise and meticulous operative procedures with much less manipulative trauma. This same sharpness also permits accidental intraocular perforation to occur with appalling ease. Because of the thinness of the sclera in childhood, accidental perforations most often occur during strabismus surgery.

CASE REPORTS

The following case reports illustrate scleral perforations resulting in panophthalmitis, cataract, massive intraocular hemorrhage, and uneventful recovery.

CASE 1

At the age of three years, this boy had strabismus surgery (elsewhere), followed by a stormy, inflammatory course. Three months later the blind, shrunken, chronically inflamed eye was enucleated. The Ophthalmic Pathology Laboratory of the University of Colorado prepared the slides illustrated in Figures 1 and 2. The pathologic diagnosis (fig. 1) was chronic endophthalmitis and phthisis bulbi, following operative perforation of the sclera. Figure 2 is an enlarged section of the operative site. The scleral perforation is clearly visible in both photographs. In other sections it was apparent that the long ciliary nerve and artery were involved in this scar.

CASE 2

This seven-year-old child sustained perforation of the sclera during a recess-resect operation for esotropia (elsewhere). Within two weeks a fully mature cataract had developed.

Fig. 1 (Havener and Kimball). Chronic endophthalmitis and phthisis bulbi, following operative perforation of the sclera.

CASE 3

One week following strabismus surgery (elsewhere) this four-year-old child was noted to have a massive hyphema with secondary glaucoma. De-

Fig. 2 (Havener and Kimball). Enlarged section of the operative site.

* From the Department of Ophthalmology, The Ohio State University, and the Department of Ophthalmology, University of Colorado.

Fig. 3 (Havener and Kimball). Severe blood staining of the cornea.

spite repeated paracentesis, severe blood staining of the cornea (fig. 3) developed and had not completely cleared one year later.

CASE 4

To reduce anesthetic risk simultaneous inguinal herniorrhaphy and medial rectus recession (Dr. Havener) were performed on this three-year-old child. As the scleral suture was being placed, the herniorrhaphy operator shook the patient. Perforation into the vitreous, behind the ora serrata, resulted. Surface diathermy was applied. One year later no complications had developed and the area of diathermy application was clearly visible with a tiny, well-healed, central hole.

DISCUSSION

A survey of Columbus ophthalmologists indicates that within a one-year period at least five eyes were accidentally perforated, only one of which is reported here (Case 4). Fortunately no complications ensued in these five cases. It is not easy to admit, or sometimes to recognize, such slips in technique, and lack of publicity leads to the erroneous conclusion that they are rare. Actually, almost every experienced surgeon knows of such incidents. The hope that others will profit from our errors and will handle sharp needles with greater care has stimulated this presentation.

"Always keep the tip of your needle in sight" is a time-honored precept which will prevent such accidents. The needle tip should never be introduced so deeply into the sclera that it cannot be seen through the translucent overlying scleral lamellae. An operative field obscured with blood is an invitation to disaster, if the sclera is not cleared before suturing.

To obtain an adequate scleral bite with the older, dull needles, it was formerly acceptable to introduce the needle perpendicularly for a fraction of a millimeter before turning parallel to the surface. Such a maneuver with a sharp needle is almost guaranteed to result in a perforation. Modern needles should enter the sclera almost tangential to its surface. Scleral sutures should not be placed while the eye or patient is moving.

SUMMARY

Four cases of accidental scleral perforation during strabismus surgery are presented and four additional cases are mentioned. This mishap can easily be prevented by awareness of its possibility and by constant visualization of the tip of the needle.

University Hospitals (10).

DIABETIC OCULOMOTOR NEUROPATHY*

REPORT OF A CASE

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Diabetic peripheral neuropathy is commonly found in clinical practice. However, involvement of cranial nerves in diabetics is a rather infrequent occurrence. Ogle,[1] in 1866, was the first to record paralysis of the 3rd, 4th or 6th cranial nerve as a complication of diabetes mellitus. Dreyfus, Hakim and Adams,[2] in 1957, were the first to describe the pathology in a case of diabetic ophthalmoplegia. In an excellent review of the ocular complications of diabetes mellitus, Waite and Beetham[3] found only 16 instances of extraocular muscle paralysis in 4,001 cases, an incidence of only 0.4 percent.

It is the purpose of this paper to report another case of diabetic oculomotor neurop-

* From the Department of Medicine, St. Vincent's Hospital of the City of New York.

athy with some unusual findings which necessitated the exclusion of a brain tumor as a causative factor.

Case report

H. R., a white man, aged 50 years, was admitted to St. Vincent's Hospital on April 3, 1959, for a diagnostic work-up with a suspicion of brain tumor. Four weeks prior to admission he developed a throbing pain about the left side of the head and face including the eye area. At the same time he experienced pain in the left sacroiliac area and in the ensuing days intermittent bouts of diplopia and blurred vision. He described the eye symptom "as though the eye were ready to pop out."

On March 23rd, weakness of the left inferior rectus muscle was detected. A subsequent neurologic examination revealed fullness of the retinal veins on the left side with prominent loop or "suitcase handle" effect. The latter finding along with skull X-ray films which were reported to show prominent vascular markings raised the suspicion of increased intracranial pressure. One week prior to entering the hospital the double vision subsided.

Neurologic examination was again unremarkable except for marked arteriosclerosis of the retinal arteries, the previously described retinal vein changes and tenderness over the left sciatic nerve deep in the buttock with a sluggish left ankle jerk.

The fasting blood sugar was 259 and the blood urea nitrogen was 11 mg. percent. Urinalysis revealed four-plus sugar and four-plus albumin. An electroencephalogram was normal. Spinal tap revealed an initial pressure of 342 mm. H_2O and a final pressure of 240 mm. after approximately 12 cc. were removed. A bilateral carotid arteriogram revealed atherosclerosis of the right internal carotid artery but no evidence of aneurysm or brain tumor. The patient's diabetic state was well controlled by diet and insulin. One hundred μg. of vitamin B_{12} were given daily for suspected neuritis of the oculomotor and sacral nerves. Headache and pains in the left sacroiliac area subsided after about a week. The patient was last seen May 11, 1959, with no neurologic complaints or findings. A follow-up spinal tap was refused.

Discussion

The patient exhibited signs and symptoms consistent with brain tumor, namely, loss of physiologic cupping in the left optic disc, fullness of veins producing in one vein a so-called "suitcase handle" effect,* increased spinal fluid pressure of significant degree, unilateral headache and increased vascular markings on the plain X-ray films of the skull. The finding of a normal vascular pattern on bilateral carotid arteriography, together with the improvement in oculomotor function, served to rule out a brain tumor.

Diabetic ophthalmoplegia is found more often in mild diabetes of long standing, frequently complicated by retinopathy, nephropathy, peripheral neuropathy and lenticular opacities. The 3rd and 6th cranial nerves are the ones most frequently affected, the paralysis coming on more or less rapidly and clearing up in a matter of weeks or months even without specific therapy. The usual clinical picture is one of pain about the orbit with paresis of one or more of the extraocular muscles causing diplopia without involvement of the pupil. One or both eyes may be affected.

The first pathologic description[2] was in a 62-year old diabetic woman who died five weeks following the onset of her illness, approximately 24 hours after carotid arteriography was performed in order to rule out an aneurysm of the internal carotid artery. A fusiform enlargement of the retro-orbital part of the 3rd cranial nerve was found; destruction of some of the myelin sheathe and axis cylinders in the center of the nerve; an increase in the epi-, peri-, and endoneurial connective tissue and suggestive evidence of regeneration in the area of destruction; Wallerian degeneration in the distal segment; axonal reaction in the 3rd nerve nucleus in the midbrain; and arteriosclerosis of the vasa nervorum.

In a consideration of differential diagnosis, aneurysm, vascular diseases, brain tumor in the paraclinoid area, leukemia and ophthalmoplegic migraine must be borne in mind.[4,5] The symptom complex of unilateral frontal headache and oculomotor paralysis has long been recognized as characteristic of an aneurysm of the internal carotid artery. The definitive

*I have observed this phenomenon as an early finding in several cases of brain tumor before the development of papilledema. As intracranial pressure increases, engorgement of veins becomes evident. With loss of the physiologic cup the slack in one or more veins is taken up by the formation of a loop or "suitcase handle" effect as the vein crosses the rim of the optic disc.

diagnosis is made by arteriography which also delineates vascular lesions and brain tumors.

Leukemic involvement of the oculomotor nerve has also been described.[5] These cases show lymphocytosis of the spinal fluid and other signs of leukemia.

Ophthalmoplegic migraine is a rare entity and this diagnosis is to be made with caution. The combination of recurrent nausea and vomiting, lateralizing pain and ophthalmoplegia in young persons is a syndrome which spontaneously remits as the child grows older. This condition has also been called cyclic oculomotor paralysis. The paresis lasts a few hours to weeks or months or it may become permanent. The pupil is nearly always involved.

The case presented exhibited the symptoms and signs of oculomotor neuropathy classically described in diabetics. The early and complete recovery was consistent with most cases found in the literature.

Summary

Another case of diabetic oculomotor neuropathy with ophthalmoplegia has been reported wherein there was complete recovery. The pathology has been included in the discussion as well as the differential diagnosis.

2020 West Charleston.

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FAMILIAL CONGENITAL LEUKOMA

Case report and review of the literature

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The purpose of this paper is to present three cases of bilateral leukoma occurring congenitally in siblings, with a review of the literature on this disease.

Case reports

The first patient of this Negro family seen in the Evanston Hospital Eye Clinic was E. C., a girl, who was brought to the clinic in September, 1947, at the age one month. At that time she had corneal opacities centrally located in the posterior stroma. There were bands of iris adherent to these opacities. She also had a horizontal nystagmus. The eyes were not inflamed. This girl has been examined at intervals since then but fundus details have never been seen. In 1952, she was first seen to have an esotropia of about 35 diopters. The refractive error—as well as can be determined—is 0.50 diopters. Distance vision is finger counting but with a 10-diopter reading glass she reads J3 print. She is in sixth grade at sight-saving school, doing well.

Two siblings—both boys— have similar afflictions. The older boy, W. C., aged 14 years, is also mentally retarded. His vision is 20/50, right, and 20/70, left. He has no nystagmus. The younger boy, J. C., is two years of age. His corneal opacities seem less dense than the others. All three children have iris adhesions. None of the leukoma is ectatic and the eyes are in other respects normal. The children have had blood and spinal fluid serology tests, with negative results. Physical examinations were also negative. The mother has been treated for syphilis but her serology is now negative. There is no history of eye disease in either parent or in their families. In addition to the children described, there are five other siblings without eye disease.

Review of literature

Duke-Elder describes congenital corneal leukoma as a dense white opacity situated deep in the corneal substance, with or without iris adhesions. The leukoma may be ectactic and perforate. In some cases it is accompanied by other changes, such as mi-

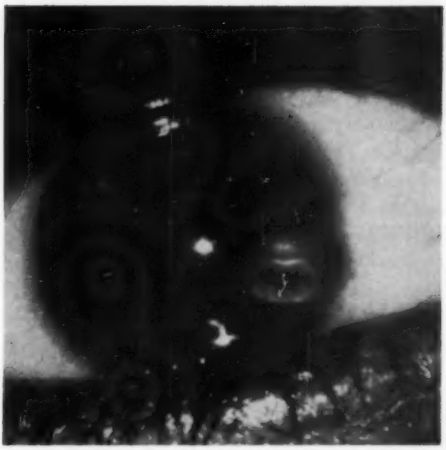

Fig. 1 (Baqueiro and Hein). Centrally located corneal opacities.

crophthalmos or iris coloboma. Tearing of Descemet's membrane in buphthalmos may produce a similar defect.

Ida Mann's reference is, characteristically, quite detailed. She described the leukoma as wedge-shaped, the base being at the endothelial surface and the point extending anteriorly, even to Bowman's membrane. Descemet's membrane is absent in the area of the opacity. Contact between lens and cornea in utero may be a cause for this condition but it is more likely a mesodermal developmental defect, the lens having nothing to do with it.

Thomas cites several cases and an experiment in rabbits, showing conclusively that congenital corneal opacities may be genetically determined. Doggart, discussing infantile corneal opacities, places the blame on a defect in development, birth injury, or postnatal ulcerations. Krimsky also lists trauma, physical and chemical, as well as infections and vitamin deficiencies, as causes of corneal defects in the newborn. However, he does not describe congenital leukoma.

Summary and Conclusions

Congenital leukoma is a rare type of corneal opacity. It is situated deep in the corneal stroma (fig. 1) and frequently the iris (fig. 2) is adherent to it. Descemet's membrane is absent in the opaque area. The leukoma is caused by a hereditary mesodermal maldevelopment and may be seen with other congenital defects, such as microphthalmos or coloboma. There is no relationship to syphilis. The familial tendency is well illustrated in the three cases described.

2650 Ridge Avenue.

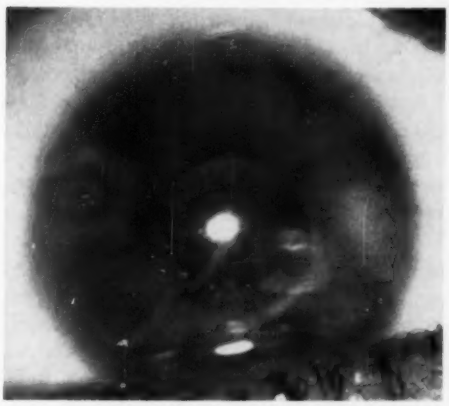

Fig. 2 (Baqueiro and Hein). Bands of iris adherent to the opacities.

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SOCIETY PROCEEDINGS

EDITED BY DONALD J. LYLE, M.D.

SWISS OPHTHALMOLOGICAL SOCIETY

September 11-13, 1959
Thoune, Switzerland

SYMPOSIUM ON GLAUCOMA

DR. E. B. STREIFF AND DR. C. STUCCHI (Lausanne) treated 71 glaucomatous eyes with diathermy coagulation applied over an extent of six mm. just behind the tendons of the horizontal muscles after prior temporary tenotomies. Destruction of the anterior and posterior ciliary arteries was thus produced. Favorable results ensued in 70 percent.

DR. P. WAGNER (St. Gall) found that Malbran's operation could be substituted satisfactorily for iridencleisis. The procedure consists of the classical basal iridectomy plus a previous coagulation of the lips of the incision by diathermy. A subconjunctival bleb results, as in iridencleisis, but the appearance of the pupil is more esthetic. He had used this technique in 25 cases and was pleased with the results. In those types of glaucoma in which an intraocular operation is contraindicated, such as cases with rubeosis iridis, thrombosis of the central retinal vein, aphakia with vitreous in the anterior chamber, absolute glaucoma, and cases not helped by previous interventions, Weekers' operation is often effective. He obtained a good result with this procedure in 27 of 35 cases. In this operation ligature of the anterior ciliary arteries is combined with diathermy of the long posterior ciliary arteries.

DR. E. ROSSELET (Lausanne) discussed exogenous glaucoma secondary to exophthalmos. This stems from increased pressure in the episcleral veins and may consequently eventuate from pulsating exophthalmos, mediastinal tumors, obstruction of the superior vena cava, or inflammatory stenosis of the jugular veins. He cited a case of orbital pseudotumor in which the exophthalmos disappeared after radiotherapy without affecting, however, the irreducible ocular hypertension.

DR. H. HEINZEN AND DR. P. LUDER (Zurich) illustrated nine personal cases of pigmentary glaucoma with goniophotographs. This syndrome is apparently not too rare, although but 28 cases have been reported since the initial description by Sugar in 1940.

DR. J. F. CUENDET (Lausanne) found that patients with primary glaucoma presented significantly more subjective and objective symptoms of neurovegetative dystonia than controls, and hence tranquillizing drugs are frequently indicated.

DR. LEYDHECKER (Bonn) considered that neurovascular factors, though not the primary cause of glaucoma, affect an eye susceptible to glaucoma much more than the normal organ. The problems of glaucoma can be understood through this synthesis of the neurovascular and mechanistic views.

DR. LOBSTEIN, DR. BRONNER AND DR. NORDMANN (Strassbourg) stressed the importance of studying glaucomatous eyes with ophthalmodynamometry. In glaucoma simplex the visual field is much more vulnerable with arterial hypotension than with arterial hypertension. Hence caution must be exercised in lowering the blood pressure of glaucoma patients, especially if the fundi reveal arteriosclerotic vessels.

DR. DUBOIS-POULSEN AND DR. MAGIS (Paris) analyzed the factors in visual-field testing in glaucoma. Perimetry with two variables, intensity and surface, is required. Visual acuity in reduced light is affected rather early.

DR. A. FRANCESCHETTI AND DR. J. CUENDET (Geneva) instituted a glaucoma service in October, 1957. All patients were asked to attend the clinic every two to three weeks. A written reminder was required for 42 percent, and a visit from the social worker for 27 percent. Only four patients failed to appear.

DR. E. AULHORN AND DR. H. HARMS (Tübingen) found a correspondence between the appearance of the disc and the deficiency in the visual field in 53 of 74 glau-

coma patients. Disagreement arose from evident vascular alterations.

Dr. T. Schmidt (Berne) outlined the procedures for the early diagnosis of glaucoma simplex.

Dr. H. Goldmann (Berne) emphasized that glaucoma should be suspected when the tension was over 21 mg. with the applanation tonometer, or above 4/5.5 with the Schiøtz instrument. Gonioscopy is essential to differentiate the type—angle-block or open-angle. Plotting the daily tension curve is of great value for confirming the diagnosis of glaucoma simplex and for determining the effectiveness of medication. In doubtful cases, tonography and the provocative tests were indicated.

Vitreoretinal degeneration

Dr. H. R. Bohringer (Schaffhouse), Dr. P. Dieterle (Geneva), and Dr. E. Landolt (Winterthour) described the clinical picture of hereditary hyaloid-retinal degeneration. This dominant form may show from infancy liquefaction and collapse of the vitreous body, avascular preretinal hyaloid bands, and circumscribed cystic retinal degeneration and atrophy. The functional prognosis is usually good, however, unless retinal degeneration is diffuse, or cataracta complicata or central choroidal sclerosis supervenes.

Dr. A. Ricci (Geneva) would classify under hereditary vitreoretinal degeneration the following syndromes:

1. Congenital vascular veils in the vitreous, inherited by males by sex-linked recessive transmission. Cystic edema of the macula is almost constantly present and may be the only manifestation. Dark adaptation is normal.

2. The dominant form just described by Böhringer and colleagues.

3. A recessive form, hyaloid-tapetoretinal degeneration, characterized by marked degeneration of the vitreous, retinoschisis, cataracta complicata, night blindness and abolition of the electroretinogram.

Surgery

Dr. A. Bangerter (St. Gall) discussed the treatment of lagophthalmos. In all cases requiring surgery, a temporary tarsorraphy is recommended as the first procedure, especially if the cornea is affected. In the milder cases that follow facial palsy, a prop for the lower lid, effected by the implantation of cartilage from the ear, reduces excessive lacrimation; and excessive elevation of the lid can be minimized by tenotomy or recession of the levator.

Dr. H. Heinzen (Zurich) presented a new stereomicroscope for ocular surgery and photography, the mounting of which facilitates rapid and precise adjustment. Magnifications of ×6, ×12, ×15 and ×50 are obtained at 10 cm., and half that much at a working distance of 20 cm.

Dr. E. Landolt (Winterthour) and Dr. H. Heinzen (Zurich) reported the pathologic findings in two cases of intracapsular extraction of cataracts in which alpha chymotrypsin had been used. Both patients were of advanced age and died five and 11 days postoperatively. Histologic examination demonstrated delayed cicatrization of the corneal stroma. The borders of the wound gaped, though showing the usual leukocytic and fibrocytic reaction.

Clinical observations

Dr. H. Goldmann and Dr. M. Favre (Berne) pointed out that, when a person's attention is directed to the extrafoveal zone, a decrease of central acuity follows; and vice versa. The essence of pleoptics is the deflection of attention from an extrafoveal zone to the fovea.

Dr. H. Werner (Davos) illustrated the progressive evolution of retinal periphlebitic lesions with 26 slides. When due to tuberculosis, early cases responded well to antituberculous chemotherapy but the outcome was dubious when the lesions were advanced. The process lies in the retrovitreal space and partial detachment of the vitreous plays an important role in complications.

Dr. S. Forni (Bellinzona) described a case of congenital cataract in a one-year-old boy due to calcifying chondrodystrophy. In this systemic disease dotlike calcifications oc-

cur at the level of the epiphyses, affecting particularly the proximal segment of the extremities, and cause shortening thereof. Other manifestations are cutaneous dystrophy, congenital cardiopathy, craniofacial anomalies, and congenital cataract.

EXPERIMENTAL STUDIES

DR. B. CAGIANUT (Zurich) examined histochemically the Kayser-Fleischer ring occurring in progressive hepatolenticular degeneration. He concluded that the pigment in the cornea is probably a silver compound.

DR. A. HUBER (Zurich) demonstrated a simple thermo-electric device by which the temperature of any part of the surface of the eyeball or lids could be measured within one second.

DR. W. SCHMID AND DR. R. BRUCKNER (Basle) examined with the slitlamp the iris and ciliary body of parrots and rooks. Movements of contraction and relaxation were noted in the pupillary part of the iris; and independent, more tonic accommodative contractions in the ciliary portion. The latter contractions rendered a number of lacunae visible, which probably serve to adjust rapidly the flow of fluid from the anterior chamber to the suprachoroidal space during the deformation of the lens by the ciliary body.

John D. Blum (Geneva),
Correspondent.
James E. Lebensohn (Chicago),
Translator.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

75th Anniversary of the Society
November 18, 1959

DR. BRENDAN LEAHEY, *presiding*

RETAINED NUCLEUS IN VITREOUS

DR. R. J. BROCKHURST presented a 33-year-old man whose right eye had a retained nucleus in the vitreous. The left eye had been lost as a result of a childhood injury. Gradual failure of vision because of a nuclear cataract had been the indication for an optical iridectomy in June, 1959. An unintentional extracapsular extraction was performed. The nucleus became dislodged into the vitreous. Alpha chymotrypsin was used during the procedure. Although the vision postoperatively could be corrected to 20/20, a retinal detachment occurred five weeks after surgery. Two scleral buckling procedures were performed. Neither were successful.

The nucleus of the lens comes forward in the vitreous to the iris plane, but there is a fine membranous attachment to the retina. Further retinal detachment surgery is indicated. Dr. Brockhurst requested suggestions as to the technique for removing the nucleus prior to the operation.

Discussion.

DR. F. H. VERHOEFF asked if the tension was normal and if there were any evidences of vitreous reaction. He suggested attempting irrigation with saline and floating the lens forward so that it could be removed with a loupe.

DR. BROCKHURST: The tension was normal and there was no evidence of active uveitis.

DR. EDWIN B. DUNPHY emphasized the toxicity of a retained lens nucleus. He recalled that he had one patient who developed a severe reaction after 10 years.

Several other suggestions were offered. These included the use of a double-pronged needle via the pars plana with the patient in a prone position to retain the lens in an anterior position. Another was to spear the nucleus under direct visualization. If a great deal of vitreous was lost during the procedures, a vitreous implant was suggested, possibly using stored vitreous. In all instances preplaced sutures were advised.

MANAGEMENT OF OCULAR COMPLICATIONS IN MARFAN'S SYNDROME

DR. H. L. BIRGE: The ocular complications in Marfan's syndrome are of two cate-

gories: (1) those that are hereditary and developmental and degenerative or (2) those that are brought about by surgery. . . . Surgery should not be performed unless the lens becomes completely (80 percent) dislocated, or cataracts impair the vision to such an extent that blindness is eminent or present. . . . It is my feeling that any complete dislocation of the lens which allows the lens to fall into the vitreous fulfills the indications for surgical removal of the lens, not only because of the danger of glaucoma but also the dangers of detached retina, choroiditis and uveitis.

The choice of surgery for the dislocated lens has caused controversy. The needling procedure is not simple. Dr. Birge believes it is likely to produce complications more frequently than a loupe extraction. He recommends iridectomy, careful wound closure and an air bubble injection into the anterior chamber. These, he claims, will minimize the severe complications.

Discussion. Dr. David Scott: Some of the lenses are well fixed but eccentric. This results in a high degree of astigmatism by retinoscopy. Is iridectomy indicated to give better vision with an aphakic correction?

Dr. Birge: I do not believe that an iridectomy can be done in these cases. I believe the lens should be removed.

Dr. Brendan Leahey: I have used the erisophake in a child, but had to remove adhesions of vitreous to the back of the lens by the use of a strabismus hook.

Dr. Birge: I do not think that the erisophake is satisfactory, especially in a small child's eye.

Surgical treatment of bullous keratopathy

Dr. Trygve Gundersen: A surgical technique previously described by Dr. Gundersen was employed in several cases with satisfactory results. Prior to the complete coverage of the cornea by the conjunctival flap, a lamellar corneal graft was performed. At a later date the central portion of the conjunctival flap was removed. The graft was found to be clear and the vision markedly improved in two cases.

Dystrophic ophthalmoplegia externa

Dr. D. G. Cogan: A case with postmortem studies of the ocular muscles, skeletal muscles, and central nervous system was presented. It is important because it is only the second case in which such extensive pathologic investigations have been available. The abnormalities were interpreted as indicating a myopathic origin for the dystrophy and not consistent with a neurogenic origin for the disturbance.

Ophthalmologist's role in prevention of automobile accidents

Dr. V. Casten presented statistics demonstrating the increasing number of fatalities due to automobile accidents. Numerous factors which included alcohol, fatigue, bad visual habits, inattention, and inconsiderate driving are involved in many accidents. Accidents in which impaired vision is a factor are being recognized more frequently. It is felt that the ophthalmologist has a moral obligation, if not a legal one, in telling his patients with visual defects that they do or do not pass the requirements for driving an automobile on the public highway.

Special contributions of ophthalmologists

Dr. L. Dame, in an interesting historical review said that the ophthalmologist was found to have taken a leading role in both the local and national medical organizations. Dr. Dame outlined the positions held by such famous ophthalmologists as Drs. Walter B. Lancaster, Allan Greenwood, and George Derby. He urged the ophthalmologist to continue taking an interest in the various state and national societies.

D. Robert Alpert,
Recorder.

AMERICAN JOURNAL OF OPHTHALMOLOGY

Published Monthly by the Ophthalmic Publishing Company

Address original papers, other scientific communications including correspondence, also books for review to *Dr. Derrick Vail, 700 North Michigan Avenue, Chicago 11, Illinois;* Society Proceedings to *Mrs. Katherine F. Chalkley, Lake Geneva, Wisconsin.* Manuscripts should be *original copies,* typed in *double space,* with wide margins.

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THE ACADEMY: 1960

The Palmer House has been transformed into a veritable mass of confusion. The S.R.O. signs are (or should be) out in the Grand Ballroom. Long lines of patient and tireless physicians stand waiting interminably for elevators from and to the fourth and seventh floors. Crowds jostle each other cheerfully amid scientific and technical exhibits with frequent pause while friend greets friend. The halls and meeting rooms are filled with serious, earnest men all of whom, from the junior resident to the distinguished professor, are filled with eager desire to see, to hear, and to learn.

Yes, the "Academy" is in session. The American Academy of Ophthalmology and Otolaryngology, the greatest educational society in our specialties, held its 65th annual session in Chicago October 9th to 14th, big-

ger and better than ever. Although at times it bears resemblance to a three-ring circus with side-shows imposed on the Grand Central Station during the commuter rush hours it never quite reaches a stage of chaos but resolves into an efficiently and smoothly operating extravaganza under the baton of the calm and unruffled Executive Secretary, "Bill" Benedict. His announcement that the ballroom would be enlarged before next year's meeting was greeted with cheers, especially from the standees, but one wonders whether the constantly increasing attendance will not soon again overtax the facilities.

The Scientific Program of the Section on Ophthalmology contained some outstanding and timely papers. Deservedly popular were the symposia, or panel discussions, which the Academy has used so effectively in recent years. Recognizing the increasing incidence of postoperative infection in the hospitals the symposium on the opening morning (a joint session with the otolaryngologists) was devoted to the epidemiology and control of hospital infections, with Drs. Ralph Adams, L. E. Cluff, H. F. Allen, and Dean A. Clark as participants. Wednesday's symposium was devoted to tonography with Dr. Kronfeld as moderator and Drs. Ballintine, Moses, Grant, Becker, and Roberts as panelists. It was the summation of the moderator that tonography was of value for more adequately evaluating glaucoma and assessing the value of medical treatment, a simplified version of aqueous dynamics which the panel felt to be of clinical value, not in conflict with other clinical data. Thursday's symposium dealt with photocoagulation, with Drs. Pischel, Clark, and Cibis relating their experiences with this new method of treatment.

At the opening session the president of the Academy, Dr. Lierle spoke on "Our Specialty Boards," and the Guest-of-Honor, Dr. Gordon D. Hoople of Syracuse, spoke on "The pursuit of excellence." Outstanding was the Jackson Memorial Lecture, sponsored by the Ophthalmic Publishing Company, and delivered by Dr. Lorenz E. Zimmerman who discussed the "Registry of Ophthalmic Pathology: Past, present, and future" in a most interesting manner. This history of the registry, its accomplishments, and potentialities were described together with pathologic illustrations.

Among the many other excellent papers presented were: "On applanation tonometry," by Dr. T. A. F. Schmidt, "Surgical management of secondary exotropia" by Dr. E. L. Cooper, "Pleoptics," by Dr. Arthur Linksz, "A major cause of hypotony," by Drs. Chandler and Maumenee, "Percutaneous renal biopsy and ocular vascular disease," by Dr. Newell, et al., "Bacterial allergy of the eye," by Dr. F. H. Theodore, "Tumors developing after radiation of the eye," by Drs. Forrest and Zimmerman, "Allergic reactivity of iris epithelium," by Drs. Dukes, Fox, and Girard, "Necrosis following detachment operations with encircling tube," by Drs. Boniuk and Zimmerman, "Electroretinogram in central degeneration," by Drs. A. D. Ruedemann, Jr., and Noell, "Motility complications in buckling procedures," by Dr. H. H. Romaine, "Reactions to dissociation and primary insufficiencies of the vertically acting muscles," by Dr. A. Urrets-Zavalia of Argentina, and "Duration of oculomotor akinesia of injectible anesthetics," by Drs. Everett, Vey, and Finlay.

Motion pictures on a variety of subjects were presented by Drs. A. B. Reese, R. W. Roberts, Alston Callahan, A. Posner, Olga Ferrer, A. B. Rizzuti, O. H. Dabezies and Frank B. Walsh. Clinicopathologic case reports were presented at the opening of most sessions.

A field in which the Academy was a pioneer among medical organizations is the program of Instructional Courses which have continued to be very popular among the members. A total of 165 individual and 56 continuous courses was offered in the field of ophthalmology at this session, with a total of 275 instructors and 390 instructional hours. Similar courses are offered in otolaryngology, certainly a most impressive record and well substantiating the Academy's claim to importance in the field of medical education.

If one is not exhausted by the scientific program and the instructional courses, by the splendid scientific exhibits, and by the overabundance of technical exhibits, there remain such meetings as the Teachers' Section, in which this year Drs. Benedict, Braley, Hogan, and Maumenee discussed the question: "How much training in research should be a part of graduate training?", the meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, and the Committee on Reconstructive Plastic Surgery: Ophthalmology. The social side is not neglected either, with speechless dinners and entertainment, and reunions of various training groups.

There was a total registration of 6,400 at this year's meeting: 2,702 fellows, 1,109 nonmember physicians, 98 candidates, and 466 residents, the balance being made up of orthoptic technicians, ladies, and technical exhibitors. Officers elected included: Dr. Dohrmann K. Pischel, president; Dr. L. R. Boies, president-elect; Dr. Frederick T. Hill, 1st vice president; Dr. Maynard Wheeler, 2nd vice president; Dr. Leland Hunnicutt, 3rd vice president; Dr. Michael Hogan, councilor, Dr. William L. Benedict, executive secretary-treasurer; Dr. Kenneth Roper, secretary for ophthalmology; Dr. Clair Kos, secretary for otolaryngology; Dr. A. D. Ruedemann, secretary for instruction, ophthalmology; Dr. Eugene Derlacki, secretary for instruction, otolaryngology; Dr. Dean Lierle, secretary for Home-Study Courses; Dr. Glen Gibson, secretary for public relations.

The next session will be at the Palmer House in Chicago on October 8-13, 1961.

William A. Mann

CORRESPONDENCE

Correction: Intravenous urea

Editor,

American Journal of Ophthalmology:

In the September, 1960, issue of The Journal, there is an article entitled "Intravenous urea in the treatment of acute angle-closure glaucoma." Unfortunately, a typographical error appears in the text which negates the purpose of the presentation. As we have had many inquiries concerning this, we should like to clarify the data.

In case report 2, the patient's preoperative tension was 60 mm. Hg, R.E. (not 6.0 mm. Hg), and 17 mm. Hg, L.E. After the administration of intravenous urea, the patient's intraocular pressure was 23 mm. Hg, R.E., and 6.0 mm. Hg, L.E. (not 60 mm. Hg).

Thank you very much for bringing these corrections to the attention of your readers.

(Signed)

Miles A. Galin, M.D.
Futaba Aizawa, M.D.
John M. McLean, M.D.
New York.

BOOK REVIEWS

The Transparency of the Cornea. A Symposium edited by Sir Stewart Duke-Elder and E. S. Perkins. Springfield, Illinois, Charles C Thomas, 1960. 266 pages, bibliography and index. Price: $10.00.

This monograph is a record of a symposium on corneal transparency held in 1958 at the seaside resort of Knokke-le-Zoute, Belgium, just prior to the International Congress in Brussels. A partial listing of those attending the symposium quickly establishes the level and value of the discussions held. For example, from England there were Ashton, Duke-Elder, Langham, Maurice and Perkins; from the United States, Cogan, Harris, Maumenee, Smelser and Vail. Continental ophthalmology was represented by Charamis of Greece, Franceschetti of Geneva, François and Rabaey of Ghent and Paufique of Lyons.

Generally the papers fall into four categories, as outlined by Duke-Elder in the introductory chapter: The normal maintenance of corneal transparency, considered under anatomy and physiology, the pathologic factors that interfere with transparency, and finally, the problem of transparency in corneal grafts.

It becomes quite apparent on reading this monograph that the study of the cornea has progressed in two directions. One group of investigators has been elucidating the fine structure of the cornea so that the simple division of cornea into five layers seems gross indeed. A second group has been investigating the cornea as a whole, and here the arbitrary anatomic divisions are ignored and the physiology of the cornea in toto is studied. Both of these approaches have been fruitful in bringing forth new facts on the basic problem of corneal transparency. A minor example is the mention of the so-called Bizzozero nodules in the corneal epithelium by François and Rabaey, a totally new fact on the very first page of the monograph. On the other hand a perusal of the sections on physiology make it apparent that one cannot ascribe transparency to any one layer but that this is a function of the cornea as a whole and depends on a normal energy turnover in the cornea, which in turn is dependent on metabolic processes. A final section of this monograph deals with problems of transparency in corneal grafts and this will be of most interest to the clinician. He will find unfortunately that answers to his problems are not simple, but he may derive some consolation from the fact that others share his problems and that much work is being done to clarify and solve them.

This book is filled with information difficult to obtain elsewhere and provides one with an opportunity to peer into some of the most athletic minds in the ophthalmologic world today.

David Shoch.

MEDIEVAL AND RENAISSANCE MEDICINE. By Benjamin L. Gordon, M.D. New York, the Philosophical Library, 1959. 764 pages, 68 plates, copious chapter notes and references, index. Price: $10.00.

Every cultured physician is, or should be, interested in the history of medicine as a whole, and particularly so in the history of his specialty. The cover lead of this excellent and interesting work states that "one of the great blind spots in medical history is the medieval period. This book fills the void by offering for the first time a thoroughly documented work on the practice of medicine during the Middle Ages and early Renaissance."

The author is a contributor on medieval physicians to the *Encyclopaedia Britannica* and the author of *Medicine Throughout Antiquity*, the *Romance of Medicine*, and *Between Two Worlds*. This work reflects his profound interest, extensive scholarship and research in the period between Claudius Galen and Thomas Sydenham. Much ancillary reading and study form an essential background for the biographies and work of medieval physicians. Therefore, not only is this book a history of medicine in the pertinent period but also a history of the time itself. The only word that adequately expresses the final product is "monumental." It is a joy to read and own.

Derrick Vail.

BLIND CHILDREN IN FAMILY AND COMMUNITY. By Marietta B. Spencer. Photographs by F. Agar, Jr., and Carol Safar. Minneapolis, University of Minnesota Press, 1960. 142 pages, index. Price: $4.25.

This profusely illustrated book shows how parents and other contacts can help blind children in eventually becoming independent adults. The excellent pictures show blind children of preschool ages in various situations and activities. The author, who specializes in medical social work, states in the accompanying text the basic principles of guidance. Blind children are essentially like other children and must be allowed to live up to their capacity. Children who achieve this, though blind, are not held back by lack of eyesight from a happy and useful life.

James E. Lebensohn.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

1

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

François, J. Verriest, G. DeRouck, A. and Rabaey, M. **Comparative study of the retinal histology and the electro-retinogram in batrachians and reptiles.** Ann. d'ocul. **193**:570-586, July, 1960.

This article is apparently the first of a series in which the authors plan to investigate the histology and the electroretinogram of batrachians and reptiles. They outline their plan of attack and devote most of this paper to a critical review of the literature. They suggest a standard set of symbols for the various elements of vision. For example, C is used for cone and a small superscript o means a cone with an oil droplet. Y stands for an indeterminate element, neither true cone nor a true rod and R stands for rod. A review of the literature of the electroretinogram in batrachians and reptiles is then given. The typical example of a batrachian is the frog and its ERG is covered in some detail. A few references are also given to the ERG in reptiles such as the crocodile, alligator, and various turtles. (3 figures) David Shoch.

Grimes, P. and von Sallmann, L. **Comparative anatomy of the ciliary nerves.** A.M.A. Arch. Ophth. **64**:81-91, July, 1960.

The anatomy of the ciliary nerves was studied in the cat, rabbit, and monkey and comparison made with the corresponding nerves in man. (12 figures, 15 references) Edward U. Murphy.

Wolter, J. R. **Nerves of the normal human choroid.** A.M.A. Arch. Ophth. **64**:120-124, July, 1960.

Normal human choroid was fixed in Cajal's solution and stained with the nerve fiber stain of del Rio Hortega. It was seen to have a rich supply of nerves of two main types: free bundles from the ciliary nerves and perivascular nerves around all blood vessels. These two systems are closely interconnected. (8 figures, 4 references) Edward U. Murphy.

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Desmonts, G., Baron, A., Offret, G., Couvreur, J. and Lelong, M. **The local production of antibodies in the course of ocular toxoplasmosis.** Arch. d'opht. **20**: 137-145, March, 1960.

The authors point out the diagnostic difficulties in ocular toxoplasmosis and the importance of developing a serologic test which can be applied to the aqueous. They note that over 80 percent of some adult populations show serum antibody and that this varies according to the dietary habits of the people, particularly with respect to the cooking of meats. Only in the young infant, therefore, is a positive serologic test of diagnostic value, although a negative test has almost absolute value at any age. However, a titre of 1/1000 or higher is considered indicative of recent systemic infection, although an ocular infection may develop without titre rise. From their study of aqueous antibodies they were able to conclude that a single aqueous determination was not diagnostically significant since antibodies could be found in the absence of ocular disease; when a higher titre was found in the aqueous than in the serum, however, a reasonably reliable diagnosis could be made. The authors regard a local production of antibody as certain proof of ocular toxoplasmosis. (6 references)

P. Thygeson.

Keckarovski, A. **The traumatic factor in the pathogenesis of allergic ocular diseases.** Klin. Monatsbl. f. Augenh. **136**.657-662, 1960.

Previous sensitization may explain severe allergic reaction of ocular tissue after trauma. The author reports on experiments with rabbits which were sensitized with cattle serum prior to corneal autografts. An anaphylactic keratitis of the remaining cornea of eye operated upon as well as edema and necrosis of the grafted part occurred. Similar results were achieved with homografts after sensitization. (2 figures, 9 references)

Gunter K. von Noorden.

Locatcher-Khorazo, Deborah, and Gutierrez, Elizabeth. **Bacteriophage typing of Staphylococcus aureus.** A.M.A. Arch. Ophth. **63**:774-787. May, 1960.

Typing showed that ocular infections are not caused by a special type or types of staphylococcus but by any of the various ones usually found in or about the eye. In unilateral infections the same type may live quietly in the normal eye. No particular type is associated with postoperative infections. (4 plates with 27 figures, 12 tables, 7 references)

Edward U. Murphy.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Armaly, M. F. **The effect of intraocular pressure on outflow facility.** A.M.A. Arch. Ophth. **64**:125-132, July, 1960.

In vitro studies of the enucleated eyes of rabbits and cats showed that the resistance of the outflow passages was dependent on the intraocular pressure level and increased linearly with it. These findings considerably complicate the investigation of outflow facility since the method of measurement may alter the variable it proposes to measure. (8 figures, 7 references)

Edward U. Murphy.

Corradi, M., Nagy, Z., and Vörösmarthy, D. **The trace-element contents of human and bovine cornea on the basis of spectrochemical analysis.** Szemészet **97**: 65-69, 1960.

The authors studied with spectrographic analysis the trace-element contents of human and bovine cornea. Besides of the elements more frequently occurring in the organism they found traces of many of the rarer elements. By means of half-quantitative analysis it was found that only iron, copper, and aluminum are present in greater quantities in the corneal ash. The quantity of other elements varies between 2 and 25 milligram percent.

Gyula Lugossy.

Geever, E. F., and Levenson, S. M. **Pathogenesis of the collagen defect in experimental scurvy.** A.M.A. Arch. Ophth. **63**.812-820. May, 1960.

Polyvinyl sponges were implanted in the abdominal walls and anterior chambers of guinea pigs which had been deprived of vitamin C. Collagen deposition was greater in the relatively avascular anterior chamber. (12 figures, 1 table, 8 references) Edward U. Murphy.

Kaufman, H. E. and Geisler, P. H. **The hematologic toxicity of pyrimethamine (Daraprim) in man.** A.M.A. Arch. Ophth. **64**:140-146, July, 1960.

This drug can cause anemia, leucopenia, and thrombocytopenia. The patients studied were 87 in number and received 25 to 100 mg. a day for at least five weeks. The most important clinical manifestations were caused by the drop in platelets and included ecchymoses, epistaxis, and increased retinal hemorrhages. These toxic effects are related to dosage and are reversible after cessation of use of the drug. (7 figures, 22 references) Edward U. Murphy.

Larsen, Godfred. **Effect of hormones on S^{35}-labeled sulfate uptake in guinea pig eye and skin connective tissues.** A.M.A. Arch. Ophth. **63**:761-766. May, 1960.

Qualitative studies were made after the animals were treated with cortisone, thyroxine, and thyroidectomy. (4 tables, 22 references) Edward U. Murphy.

Leopold, I. H. and Kroman, H. S. **Methyl- and fluoro-substituted prednisolones in the blood and aqueous humor of the rabbit.** A.M.A. Arch. Ophth. **63**:943-947, June, 1960.

Penetration of these forms of prednisolone (Decadron, Medrol) into the aqueous humor was superior to that of triamcinolone (Kenacort) in the rabbit. (2 figures, 4 references) Edward U. Murphy.

Lugossy, G. **Clinical fluorometry and senescence.** Ann. d'ocul. **193**:410-418, May, 1960.

The author studied the rate of transfer of fluorescein across the ciliary body in 10 young adults and 10 old adults. In the old adults permeability to fluoroscein is decreased both under normal conditions and after corneal puncture. (4 figures, 18 references) David Shoch.

Marci, F. J. **Acetazolamide and the venous pressure of the eye.** A.M.A. Arch. Ophth. **63**:953-965, June, 1960.

The cat eye was studied in vivo and in perfusion experiments. Acetazolamide causes the venous pressure of the eye to fall but the mechanism of this effect is not yet clear. (10 figures, 1 table, 19 references) Edward U. Murphy.

Merola, L. O., Kern, H. L. and Kinoshita, J. H. **The effect of calcium on the cations of calf lens.** A.M.A. Arch. Ophth. **63**:830-835. May 1960.

Lens cultures were employed and the calcium concentration found important in maintaining the potassium and sodium levels in the lens. The optimal level of calcium in the artificial medium is 9.2 mg. percent (4 tables, 12 references) Edward U. Murphy.

Paganoni, C. **Action of opilon on the pupil.** Arch. di ottal. **64**:15-22, 1960.

Opilon is a miotic solution of the chlorhydrate of 6-aceto-thymo-ethyl-dimethylamine. In 0.5 percent strength, it was found free from uncomfortable side effects and clinically effective. In 5 percent strength, it caused painful chemosis, slight ptosis as in Horner's syndrome, and a miosis lasting from 24 to 48 hours. The effect was studied in 20 subjects by pupillography and light stimulus. (2 figures, 12 references) Paul W. Miles.

Papapanos, G. and Trichtel, F. **Corticosteroids in the aqueous of the rabbit's**

eye after local and parenteral application. Arch. f. Ophth. **162**:72-77, 1960.

In an earlier study the authors showed by means of the Tetrazol blue test that the average corticosteroid level in the aqueous of the rabbit is 341γ-percent. In this communication they show that it is possible to raise the corticosteroid content above the mg.-percent limit by applying corticosteroids locally and parenterally. (3 tables, 19 references)

F. H. Haessler.

Pillat, A. and Schenk, H. **Experimental study of the mode of action of Sympatol in chemical burns of the eye.** Arch. f. Ophth. **162**:97-106, 1960.

In this experimental study four rabbits were used; in each animal both eyes were given local anesthesia and an area of cornea and conjunctiva was cauterized with a pencil of caustic soda. The right eye was left untreated in each rabbit. In rabbit No. 1 the left eye was given one bath with Sympatol solution. Both eyes were enucleated at the end of one hour and studied histologically. Rabbit No. 2 was given four baths with Sympatol at six-hour intervals and the eyes were enucleated at the end of 24 hours. In rabbit No. 3 the left eye was given 12 Sympatol baths at six-hour intervals and both eyes were enucleated at the end of 72 hours. Rabbit No. 4 was treated similarly and the eyes were enucleated after 30 days. On the basis of the histologic findings the authors attempt to explain various clinical observations made in the course of Sympatol therapy of the cauterized eye. (6 figures, 5 references)

F. H. Haessler.

de Roetth, Andrew, Jr. **Annual reviews. Ophthalmic pharmacology and toxicology.** A.M.A. Arch. Ophth. **64**:292-317, Aug., 1960.

The literature from early 1959 to early 1960 is discussed. (186 references)

Edward U. Murphy.

Schenk, H. and Kunze, R. **Ocular damage with cortisone.** Klin. Monatsbl. f. Augenh. **136**:663-672, 1960.

The pharmacologic actions of cortisone and its effect on various body functions are discussed. The literature dealing with ocular complications after topical cortisone is reviewed. During the last eight years, the author observed ten patients in whom cortisone led to severe corneal damage. Case reports are given. (29 references)

Gunter K. von Noorden.

Schmidt, J. G. H. **The neuraminic acid content of the eyes of various mammals. I. The cornea.** Arch. f. Ophth. **162**:34-47, 1960.

In the mucoid fraction of the corneal parenchyma and the endothelial portion of the eyes of cattle, horse, and pig, a compound is found which has many of the characteristics of the neuraminic acid which has been isolated from serum of cattle. It is obviously bound to certain protein bodies. The author calls attention to the relationship to the Pfaundler-Hurler syndrome. (3 figures, 57 references)

F. H. Haessler.

Schmidt, J. G. H. **The neuraminic acid content of the eyes of various mammals. II. The aqueous.** Arch. f. Ophth. **162**:48-52, 1960.

The neuraminic acid of the aqueous is essentially a component of the α globulin fraction. (2 figures, 14 references)

F. H. Haessler.

Smith, J. L. and Douty, E. **Electrophoresis of subretinal fluid.** A.M.A. Arch. Ophth. **64**:114-119, July, 1960.

Using the method of paper electrophoresis it was found that the protein content increased with the duration of the retinal separation, as has been stated previously. Microchemical analysis in two cases showed a very great increase in protein over the value for normal vitre-

ous. The mechanism of this increase is unknown. (5 figures, 2 tables, 8 references) Edward U. Murphy.

Steinvorth, E. **Further experimental study of the effect of various medicaments on the paper-electrophoretic behavior of the water-soluble protein of the corneal epithelium of the calf.** Arch. f. Ophth. **162**:28-33, 1960.

In a previous study Steinvorth had reported the effect of the local application of commonly used medicaments on those proteins of the watery extract of the corneal epithelium of the calf which could be represented paper-electrophoretically. In this contribution the effect of the same medicaments on a pulp from the same source is described. Of 33 substances used only six showed essential differences, namely Dulcargan, zinc sulphate, tannin, Aristamid, Alloxan, and Veritol. (5 figures, 1 reference)

F. H. Haessler.

4
PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Arruga, Alfredo. **The value of moving figures in the treatment of suppression.** Arch. Soc. oftal. hispano-am. **20**:111-122, Feb., 1960.

Arruga describes in detail his pleoptic and orthoptic technique. He incorporated into the Lyle synoptophore devices which permit the use of afterimages, Haidinger brushes, and motion picture slides. The motion in the interchangeable slides comes from a circular holder rotated by a microelectromotor. Arruga thus aims to utilize the antisuppressive power of color and motion. The anti-suppression treatment is applicable only to cases of normal retinal correspondence. Anomalous correspondence should be corrected before elimination of suppression is begun. In order to avoid small residual angles of anomalous correspondence Arruga advocates checking correspondence with afterimages and Haidinger brushes in the course of the orthoptic treatment. (7 figures)

Ray K. Daily.

Beiras Garcia, A. **Suggestions for improving orthoptic technique.** Arch. Soc. oftal. hispano-am. **20**:126-151, Feb., 1960.

Beiras who invented several contrivances for orthoptic therapy, among them, a cinepleoscope, an ortocine and a hydroelastic prism, describes in detail the improvements which he gradually developed in these devices and his method of therapy. (12 figures, 7 references)

Ray K. Daily.

Görtz, Heinz. **A study of visual acuity during binocular vision in amblyopia which has been treated.** Arch. f. Ophth. **162**:24-27, 1960.

When testing patients who had had amblyopia with eccentric or inadequate central fixation, a discrepancy is frequently found between the vision in the amblopic eye and the stereoscopsis which can be achieved as a measure of correspondence in space. A better visual acuity is achieved in the amblyopic eye during binocular visual tests than monocular testing led one to expect. In explanation the difference between the scotoma during monocular and binocular viewing is analyzed. (1 figure, 5 references)

F. H. Haessler.

Jäger, A. **X rays and functional arrangement of the retina.** Klin. Monatsbl. f. Augenh. **136**:617-620, 1960.

X rays are perceived as light when they fall on the retina. They are localized according to the spatial value of the stimulated retinal element. Experiments have revealed, however, that stimulation of pre-equatorial retinal elements are localized differently from what is expected. Critical experiments are needed to es-

tablish whether this phenomenon can be explained by secondary irradiation from the lens. (1 figure, 7 references)

Gunter K. von Noorden.

Junes, E. **The cyclopean retina.** Ann. d'ocul. **193**:419-445, May, 1960.

The phenomenon of binocular vision is best understood by predicating a cyclopean retina. The author investigates the characteristics of the horopter and fusion to illustrate the usefulness of this model. The first stage of action of the cyclopean retina is the reconstitution of the segmented monocular image appearing on the peripheral retina. This corresponds to physiologic diplopia which can be seen either at near or at distance. The second action of the cyclopean retina is the fusion of the two monocular images into a single image. This corresponds to the vision of relief which is observable only in near vision. The third action of the cyclopean retina is the projection into visual space of these monocular and binocular images. (5 figures)

David Shoch.

Mandelbaum, Joseph. **An accommodation phenomenon.** A.M.A. Arch. Ophth. **63**:923-925, June, 1960.

The author describes the interesting phenomenon of an apparently purely reflex accommodation induced by the interposition of an ordinary wire mesh screen between the observer and his object of regard. The use of a cycloplegic abolished the induced myopia in two subjects. The author suggests the possibility that dirt and other imperfections on the windshields of cars and airplanes may interfere with distance vision because of this effect. (6 references)

Edward U. Murphy.

Oppel, O. **The legal evaluation of questionable unilateral amblyopias. Differential diagnostic considerations.** Klin. Monatsbl. f. Augenh. **136**:563-568, 1960.

A dark adaptation curve may help to differentiate between functional and organic amblyopia in questionable cases. Except in the initial phase of the curve where the cone function may be slightly decreased in functional amblyopia, the curve remains normal throughout in the latter condition. Patients with damage to the optic nerve fibers show gross deviation from the normal in their dark adaptation curve. (3 figures, 11 references)

Gunter K. von Noorden.

Rodger, F. C., Dhir, P. K. and Mozzain Hosian, A. T. M. **Night blindness in the tropics.** A.M.A. Arch. Ophth. **63**:927-935, June, 1960.

Investigation of the dark-adaptation curves, stools, and the vitamin A and carotenoid levels in the blood was carried out in 105 patients selected at random. It is suggested that hemeralopia in the tropics may be due to a protein deficiency as well as to lack of vitamin A. Intestinal parasites may compete with their hosts for both substances. No evidence was found that prolonged exposure to bright tropical sunlight raised the threshold of dark adaptation in the native population. (1 figure, 4 tables, 21 references)

Edward U. Murphy.

Snydacker, Daniel. **Annual reviews: Optics and visual physiology.** A.M.A. Arch. Ophth. **63**:1029-1065, June, 1960.

The literature for 1959 is discussed. (288 references)

Edward U. Murphy.

5

DIAGNOSIS AND THERAPY

Allen, H. **Recent advances in aseptic surgical technique.** Tr. Am. Acad. Ophth. **64**:493-499, July-Aug., 1960.

Endophthalmitis now occurs in about two of each 1,000 cataract extractions. The etiologic agent is Staphylococcus aureus in two fifths of cases and gram neg-

ative bacilli in one third of cases. Multiple infections have occurred after the use of benzalkonium chloride, saline, and sulfonamide solutions.

The incidence was eight times greater in second eyes operated upon during the same hospital admission in which the uninfected fellow-eyes was done. Also the incidence is eight times greater after extracapsular extraction than after intracapsular.

In order to decrease this incidence scrubbing with green soap for two minutes followed by a two-minute rub with 75 percent isoproponol for the lids and brow is advised. Instruments and equipment should be sterilized by dry heat, or if this cannot be tolerated, by formaldehyde, ethylene oxide or beta-propiolactone gas. Sterile solutions, surgical silence, more efficient masks, and adequate ventilation also are advised. (2 tables, 14 references) Harry Horwich.

Baum, Gilbert and Greenwood, Ivan. **Ultrasonography—an aid in orbital tumor diagnosis.** A.M.A. Arch. Ophth. **64**:180-194, Aug., 1960.

An important new diagnostic method is explained and the findings in two representative cases described. Orbital lesions can be visualized and localized by this technique when all other tests are negative. Ultrasonography can be likened to slitlamp microscopy in which high frequency sound replaces the light source. The image is similar to radar or television and permanent records are made by photographing them. (25 figures, 1 reference) Edward U. Murphy.

Berk, M. M. **A critical evaluation of color perimetry.** A.M.A. Arch. Ophth., **63**:966-977, June, 1960.

The energy of blue or green light determines the field size rather than the color of the light, if the discrimination of an object rather than a color is used as an end point. Four fields were done on each of 150 normal subjects. (18 figures) Edward U. Murphy.

Bleeker, G. M. **Serial recordings of the depth of the anterior chamber.** A.M.A. Arch. Ophth. **63**:821-829. May, 1960.

This was done photographically and revealed continuous alterations in the position of the ocular diaphragm hourly and over a period of days in both normal and glaucomatous eyes. The effects of various drugs were followed also. This technique can yield valuable information about changes in the volume of the anterior and posterior segments and their relation to the maintenance of intraocular pressure. (11 figures, 21 references) Edward U. Murphy.

Casanovas, Jose and Olivella, Antonio. **New advances in the use of photocoagulation.** Arch. Soc. oftal. hispano-am. **20**:251-263, April, 1960.

Brief reference is made to the development of photocoagulation from its beginning with utilization of sunlight to the development of the Zeiss photocoagulation apparatus. The application of this form of therapy for xanthelasma, papillomas, sebacious cysts of the lids, subconjunctival hemorrhage, small benign tumors of the conjunctiva, pinguecula, pterygium, corneal vascularization, absorption of postoperative and diabetic rubeosis iridis, hemorrhage, tumors of the fundus, and retinal detachment are described. In two cases of angiomatosis of the retina the author obtained a favorable result in one case, but the treatment failed to arrest the progress of the second case. (10 figures, 15 references) Ray K. Daily.

Eissler, Rolf. **Photocoagulation.** A.M.A. Arch. Ophth. **63**:993-996, June, 1960.

Most lesions treated by this method are in the peripheral area of the retina. In-

creased energy must be delivered to these areas because of the relative decrease in pupillary aperture due to the increase in obliquity. A table is supplied to show the increase in energy needed as the periphery is approached. Almost double the energy is needed at 70° as compared to the zero position. (1 table, 16 references) Edward U. Murphy.

Finnerty, F. A., Foote, W. D., DeCarlo Massaro, G., Tuckman, J., Buchholz, J. H. and Ryan, M. J. **The significance of lateral and generalized retinal sheen.** Ann. Int. Med. **52**:819-826, April, 1960.

The differential diagnosis between toxemias of pregnancy and acute exacerbations of chronic hypertension during pregnancy remains a difficult problem. Observation of the retinal vessels is often helpful, but additional clues would be welcomed. The authors describe a "generalized retinal sheen," which they believe is characteristic of either toxemia or acute glomerulonephritis and not present as a part of chronic, hypertensive retinopathy. The "sheen" is a glistening, wet appearance of the retina, due to many, fine, reflecting high-lights. It is said to be present normally at the posterior pole and over the temporal half of the retina, and in normals is said only rarely to extend more than two disc diameters nasal to the nerve head. This normal sheen occurs in the vast majority of people under 30, in 75 percent of those in the 30 to 42 age group, and in only 4 percent of people over 42. Involvement of the nasal retina is pathological. Administration of chlorothiazide eliminates the generalized sheen but not the normal sheen, indicating to the authors that only the former is due to edema. Generalized sheen was present in 23 out of 30 cases of toxemia, and absent in 262 normal individuals. Unfortunately, correlative blood pressure studies are not reported. Lawrence T. Post.

Gaipa, M. **A note on photographic technique of the pupillary red reflex, and of the fundus with light of different wavelength.** Arch. di ottal. **64**:11-14, 1960.

(3 figures, 6 references)

Paul W. Miles.

Gernet, H. **Index finger test in examination for nasal constriction of the visual field.** Ann. d'ocul. **193**:516-520, June, 1960.

This simple test consists of the observation of the index finger placed in the nasal field of the eye being examined. Because of the obstruction presented by the nose, a finger, seen in the nasal field when the eye is directed ahead, is not visible when the eye is rotated nasally. On the other hand, if there is retraction of the nasal field, the index finger will be visible, with the eye directed straight ahead and nasally. The authors feel that the chief benefit of this test is the fact that the patient can perform it on himself. (4 figures) David Shoch.

Goodman, George and Ripps, Harris. **Electroretinography in the differential diagnosis of visual loss in children.** A.M.A. Arch. Ophth. **64**:221-235, Aug., 1960.

This objective test of retinal function is particularly valuable in the clinical examination of children with visual loss and a normal fundus. Ophthalmoscopic changes are frequently absent in the early stages of retinal degenerations and in many of the congenital retinal anomalies. Children below six years of age can be examined successfully when one uses sedation and topical anesthesia. An ERG can usually be taken in patients with nystagmus. (48 references)

Edward U. Murphy.

Grossman, E. E. and Hanley, William. **Transient myopia during treatment of hypertension with autonomic blocking**

agents. A.M.A. Arch. Ophth. **63**:853-855, May, 1960.

A 24-year-old hypertensive man, treated with hydralazine and hexamethonium after bilateral sympathectomy, showed a myopia due to ciliary spasm. When the drugs were decreased the myopia disappeared and when they were increased it returned. (8 references)

Edward U. Murphy.

Hallett, J. W., Wolkowicz, M. I., Leopold, I. H. and Wijewski, E. **The Middlebrook-Dubos test in uveitis.** A.M.A. Arch. Ophth. **63**:1016-1017, June, 1960.

After studying 200 cases of endogenous uveitis, the authors conclude that this agglutination test is not useful as a screening method for tuberculosis. (14 references) Edward U. Murphy.

Huey, T. F., Jr. **A cutter for prethreaded polyethylene tubing.** A.M.A. Arch. Ophth. **63**:790, May, 1960.

Scissors modified for cutting the polyethylene tubing used in scleral buckling are described. (2 figures)

Edward U. Murphy.

Imparato, A. M. and Lord, J. W., Jr. **Ophthalmological reviews. Arterial surgery.** A.M.A. Arch. Ophth. **63**:1018-1028, June, 1960.

This is a review of recent advances and the current status of arterial surgery described by specialists in this field. The treatment of such lesions as patent ductus arteriosus, coarctation of the aorta, aneurysm, aortic arch syndrome, and carotid artery occlusion is discussed. (51 references) Edward U. Murphy.

Jayle, G. E. and Boyer, R. L. **The principles and clinical interest of dynamic electroretinography.** Arch. d'opht. **20**:14-20, Jan.-Feb. 1960.

The authors review the general principles of electroretinography, including the exploration of the retina 1. at different levels of activity, in both light and dark adaptation, 2. under different conditions of stimulation with different wavelengths of light, and 3. by means of simultaneous electroencephalography when possible. The article is well illustrated with tables of findings in normal and pathologic subjects but does not contain a review of the literature. Reference is made to the 1959 monograph of Jayle, Boyer, and Camo on this subject. (1 figure, 4 charts)

P. Thygeson.

Kapuscinski, W. J. and Ogielska, E. **The dynamic cytogram of the aqueous humor in the course or iridocyclitis treated by cortisone and typhoid vaccine.** Arch. d'opht. **20**:21-27, Jan.-Feb., 1960.

The senior author, Kapuscinski, has long been interested in the differential cytology of the aqueous in uveitis when under the influence of various therapeutic measures. In the present study the authors report the effect of cortisone and typhoid vaccine on the aqueous cytogram:

$$\frac{\text{reticuloendothelial cells + monocytes.}}{\text{neutrophils + lymphocytes}}$$

Reduction of the inflammation by typhoid vaccine was reflected in a relative increase in the reticuloendothelial cells and monocytes and in a decrease in the neutrophils and lymphocytes. The effect of cortisone was much less striking. The authors conclude that cortisone does not stimulate local defences as the foreign protein does, and that this accounts for the fact that clinical improvement with the steroids is often deceptive. The cytograms are presented in the form of graphs. (3 figures, 7 references)

P. Thygeson.

Koleszár, Gy. **Today's problems of trachoma treatment.** Szemérzet **97**:104-108, 1960.

The author reports the treatment of 1,845 patients in several combinations. According to this experience and in accordance with some foreign author's opinion the best results in treating patients with trachoma can be obtained even today by using sulfonamid-antibiotic therapy combined with classical mechanical treatment. Gyula Lugossy.

Lincoff, H. A. **Intractable granuloma as a complication of polyethylene tube buckling procedures.** A.M.A. Arch. Ophth. **64**:201-207, Aug., 1960.

Four cases of granuloma are reported occurring in a total of 94 operations. The eyes remained red and irritable and after the sixth week a pink mass became visible. Conservative treatment failed in all and a surgical procedure to remove or sterilize the tube was necessary. The first tube removed contained a pure culture of Staphylococcus aureus in its lumen. Antibodies and chemotherapeutic agents cannot reach such enclosed spaces. Extra precautions must be taken with sterile skin preparation and technique in these cases. (1 plate) Edward U. Murphy.

Moron-Sales, Jose. **The brilliancy of the luminous focus in photocoagulation.** Arch. Soc. oftal. hispano-am. **20**:264-295, April, 1960.

This is a comprehensive presentation of the physics of light involved in the action of photocoagulation of the anterior ocular segment of the fundus. The technical requirements of the photocoagulation apparatus are explained in detail. It is pointed out that a much lower light intensity suffices for photocoagulation of the anterior ocular segment, and a device is described which can be used effectively for this purpose, and which can be obtained at a much lower cost than the Zeiss photocoagulation apparatus. The author's own investigations on animals, and the heretofore unreported investigation of Diaz Dominguez with transcleral photocoagulation of the ciliary body for glaucoma are described. Diaz Dominguez abandoned his investigation because of corneal complications of the procedure. The author's investigations in the field of photocoagulation, as well as the development of a less expensive apparatus, will be the subject of later reports. (15 figures) Ray K. Daily.

Orbán, T. **Use of Pantesin-Hydergin (PH 203) and Exacthin (ACTH) in the treatment of circulatory diseases of the retina.** Szemészet **97**:90-96, 1960.

The author reports on the use of PH 203 plus ACTH in the treatment of retinal thrombosis, of macular processes of exudative type, of tapetoretinal degeneration and of embolism. The rapid and reliable improvement of vision was especially conspicuous in the cases of thrombosis and macular processes with serious bleedings. No improvement was found in patients with embolism and tapetoretinal degeneration. In contrast to the coagulation inhibitive drugs no complications were observed; bleedings never occurred. Laboratory control tests showed no pathologic changes. Ambulant patients can be treated too. Gyula Lugossy.

Parsons, O. A. and Gottlieb, A. L. **Visual field impairment in brain damage. Cross validation and reliability of a method of flicker perimetry.** A.M.A. Arch. Ophth. **63**:1009-1015, June, 1960.

The flicker-perimetry method of Miles is concluded to be a valid and reliable indicator of visual impairment associated with brain damage. The authors studied 22 subjects and 22 controls. (8 tables, 7 references) Edward U. Murphy.

Rees, Thomas D. **The transfer of free composite grafts of skin and fat: A clinical study.** Plast. & Reconstruct. Surg. **25**: 556-563, June, 1960.

Of 16 free composite grafts 10 were successful. There were three partial failures and three complete failures. The use of free composite grafts of skin and fat is not proposed as a practical clinical method by the authors at this time.

Alston Callahan.

Sartori, C. and Looft, D. **Possible causes of postoperative hemorrhages and their management.** Klin. Monatsbl. f. Augenh. **136**:557-560, 1960.

A short review of the clotting mechanism is given and the more common disturbances are discussed. Two cases are discussed where excision of a chalazion was followed by severe hemorrhages which required hospitalization. Topical treatment with an aqueous solution of 3000 I.U. active thrombine stopped the bleeding in both instances immediately. (1 table, 4 references)

Gunter K. von Noorden.

Sears, M. L., Walsh, F. B. and Teasdall, R. D. **The electromyogram for ocular muscles in myasthenia gravis.** A.M.A. Arch. Ophth. **63**:791-798. May, 1960.

Action potentials were recorded from affected ocular muscles in seven patients and showed the expected tiring and recovery with rest or intravenous edrophonium chloride. Six of these patients showed irreversible changes in the electromyographic pattern suggesting that myopathy is present more frequently than clinical reports indicate. (4 figures, 22 references) Edward U. Murphy.

Thompson, Noel. **The subcutaneous dermis graft—a clinical and histologic study in man.** Plast. & Reconstr. Surg. **26**: 1-21, July, 1960.

After outlining in brief the development of dermis grafts, the technique of construction of such a graft is presented. The grafts are taken from the deltoid region of the arm in men, the submammary groove in women, or the lateral aspect of the thigh. First, a thin Thiersch graft is cut off freehand, and then the remaining skin layers with as little adherent fat as possible are excised as a free dermis graft. The graft is inserted into the prepared subcutaneous bed, doubled upon itself to form a graft of double thickness with the superficial surface of the graft in contact with host tissues. When the defect is extensive, a second doubled dermis graft is used at a subsequent operation, rather than a multiple layer dermis graft as a single procedure. The author reports 33 cases of minor facial contour defects, some orbital in location, that were corrected with dermis grafts. The results are analyzed and illustrated; 90 per cent of the grafts were successful.

Alston Callahan.

Valenta, A. and Tóth, I. **New operative method of corneal tatooing.** Szemészet **97**:78-81, 1960.

staining is simpler than the methods used

Reduced with vitamine C palladium so far; it can be quickly performed and yields the best cosmetic results. The absorption of the dye is not too rapid, it lasts many years and may be repeated without any danger. As a deep-black staining material, palladium oxide deserves more attention and further testing in other domains of cosmetics too.

Gyula Lugossy.

Wheeler, M. C. **Punch cards for motility records. A follow-up report.** A.M.A. Arch. Ophth. **63**:799-800. May, 1960.

The multiple card system is not practical and does not eliminate the need for taking out the actual case records although it is a means for finding the proper ones. A single card system to achieve the same end would be better.

Edward U. Murphy.

Wiesinger, Herbert, Dupont, Guerry, III and Geeraets, W. J. **Recent experi-**

ences with light coagulation. A.M.A. Arch. Ophth. **64**:254-259, Aug., 1960.

Good results were obtained in 30 of 32 cases of early retinal detachment with peripheral tears. Small angiomatous lesions, areas of neovascularization, and macular holes were also treated with success. The macular holes were coagulated when vision was less than 20/200 to prevent subsequent retinal detachment. This treatment appeared to be of value in a few cases of recurrent acute choroiditis. (5 figures, 2 tables, 7 references)

Edward U. Murphy.

Zajácz, M. **Therapy in Sjögren's syndrome.** Szemészet **97**:108-110, 1960.

In a patient in whom the usual therapy failed, the implantation of calf's hypophysis resulted in a four-months period free of complaints. Gyula Lugossy.

6

OCULAR MOTILITY

Chamberlain, W. P., Jr. **Annual reviews. Strabismus.** A.M.A. Arch. Ophth. **64**:147-158, July, 1960.

The literature for 1959 is reviewed with emphasis on Pleoptics, A and V syndromes and electrophysiology of the ocular muscles. (167 references)

Edward U. Murphy.

Chesnais, A. **Strabismus in univitelline twins.** Ann. d'ocul. **193**:501-515, June, 1960.

Six cases of identical twins with strabismus are added to the 86 already published. Of these 92 pairs of twins, 76 per cent showed a similar dysfunction while in 24 per cent it was dissimilar. Although this indicates that a hereditary factor is present in strabismus, it does not permit one to conclude that disorders of binocular vision are necessarily hereditary. Apparently ametropia is the hereditary factor and it is the cause of strabismus in most cases. (12 references)

David Shoch.

Da Luz, B. **Clinical orthoptica.** Arq. brasil. de oftal. **23**:13-18, 1960.

The author makes a plea for the early treatment of strabismus during the formative period of infancy and childhood when binocular vision is being developed. Two sketches are presented to illustrate normal and abnormal retinal correspondence. Complications such as amblyopia, defective fusion, and monocular vision may be avoided by early and definitive treatment. James W. Brennan.

Doden, W. and Protonatorios, P. **Anamnesis and ocular functions in healthy children.** Klin. Monatsbl. f. Augenh. **136**: 459-476, 1960.

An extensive ophthalmologic and orthoptic examination was given to 100 healthy children between four and nine years of age, to determine the normal variations of sensory and motor functions and the applicability of certain diagnostic tests and therapeutic procedures in this age group. Tables demonstrate the normal variations of various measurements. The authors conclude that insufficient convergence movements in children of this age group do not indicate insufficient binocularity. Using four different diagnostic methods, orthophoria was only rarely found to be present. The average fusional amplitudes for all children are computed. (7 tables, 60 references)

Gunter K. von Noorden.

Dunlap, E. A. **Selection of operative procedures in vertical muscle deviations.** A.M.A. Arch. Ophth. **64**:167-174, Aug., 1960.

Surgery for the various vertical muscle defects is discussed and emphasis placed on the principles used to select the proper procedures. The A-V syndromes are considered and the author finds several schools of thought currently. He feels that there is no single cause and that different or multiple sets of muscles are in-

volved. No definitive surgical approach is possible yet. (11 references)

Edward U. Murphy.

Ehrich, W. **Photography of motility problems.** Klin. Monatsbl. f. Augenh. **136**:561-563, 1960.

An arrangement is described which permits photographic recording of the positions of gaze in patients with strabismus. (3 figures)

Gunter K. von Noorden.

Jonkers, G. H., Vader, J. and Weil, H. J. **Results of orthoptic treatment of decompensated phorias.** Klin. Monatsbl. f. Augenh. **136**:449-459, 1960.

The authors treated 64 patients with decompensated phorias orthoptically and discuss the results. The treatment consisted of antisuppression and physiological diplopia exercises, training of fusional amplitudes and the accommodation-convergence ratio. Only one patient needed surgery. The results were good in patients with convergence insufficiency, divergence excess, and normophoria with weakness of fusion. Orthoptics is the therapy of choice in these anomalies; surgery and prismatic correction have supportive value only. (1 figure, 8 tables, 19 references)

Gunter K. von Noorden.

Krüger, K. E. **Contribution to the operation after Kestenbaum for nystagmic torticollis.** Klin. Monatsbl. f. Augenh. **136**:477-482, 1960.

The procedure consists of advancement of one horizontal rectus muscle and recession of the other. Successful employment of this procedure is reported in a nine-year-old patient. Torticollis disappeared after nystagmus ceased to be present in the primary position after surgery. The indications for this procedure are mentioned. (4 figures, 8 references)

Gunter K. von Noorden.

Matteucci, P., Pasino, L. and Cordela, M. **Criticism of the theory of Harms of the persistent inhibition in an eye with amblyopia and strabismus.** Ann. d'ocul. **193**:485-492, June, 1960.

The authors review the theory of Harms on amblyopia in strabismus. They agree that inhibition does exist in binocular vision in squint patients but that inhibition cannot explain monocular amblyopia. They feel that previous work demonstrating central scotomas in the amblyopic eye is invalid because the good eye was always used as the fixing eye. They find no alteration in either the pupillary response or the electroretinogram of the amblyopic eye. This leads them to the conclusion that the effectiveness of Cüpper's technique of treating amblyopia is due to reeducation of the normal sensori-motor coordination of the amblyopic eye. (3 figures, 19 references)

David Shoch.

Miller, J. E. **Vertical rectus transplantation in the A and V syndromes.** A.M.A. Arch. Ophth. **64**:175-179, Aug., 1960.

The vertical rectus muscles are secondary adductors and all varieties of the A and V syndromes can be treated by increasing or decreasing their horizontal actions in the direction of the greatest tropia. For example, in A esotropia both superior rectus muscles are transplanted 7-mm. temporally. In 18 patients so treated good results are reported in all except the three with A exotropia. The procedure was most effective when combined with horizontal muscle surgery. There were no disturbances in lid position. (5 figures, 12 references)

Edward U. Murphy.

Nicolato, V. **Clinical and etiologic aspects of nystagmus. Possibilities of treatment.** Arch. di ottal. **64**:31-69, 1960.

This is an excellent and complete review of the recent European literature on

nystagmus. The author discusses particularly Kestenbaum's classification, and then modifies it to identify the physiologic types. Physiologic nystagmus includes opticokinetic, fatigue in extreme lateral gaze, and provoked labyrinthine and vestibular nystagmus.

The author described in detail miners' nystagmus, spontaneous vestibular nystagmus, vertical nystagmus from a lesion of the corpus quadrigemini or pineal body, convergence nystagmus as in multiple sclerosis, retraction nystagmus, spontaneous acquired nystagmus, and congenital nystagmus due to ocular disease.

Therapy with barbiturates, tranquilizers, artane, orthoptics, glasses, prisms, and ocular muscle surgery is discussed. It is concluded that horizontal rectus surgery should be done for strabismus, with considerable hope of relief. Without strabismus rectus recessions have been reported helpful, but not conclusively. Prisms have been unsuccessful, probably because 20 or more diopters cannot be put into glasses. Paul W. Miles.

Ohm, J. **The nature of dissociated miners' nystagmus.** Klin. Monatsbl. f. Augenh. **136**:491-499, 1960.

The development of research in miners' nystagmus during the past 50 years is reviewed. On the basis of his own observations the author concludes that miners' nystagmus is frequently dissociated, as far as the position of the globes is concerned, but associated in regard to antagonistic and synergistic innervation (Hering's law). (3 figures, 15 references)

Gunter K. von Noorden.

Papolczy, F. **A new procedure to improve surgical results in strabismus.** Klin. Monatsbl. f. Augenh. **136**:482-491, 1960.

Scar formation of the muscle sheath and overlying conjunctiva may influence the surgical result unfavorably. The author reports his method which consists of recessing the muscle with its sheath and suturing the conjunctival incision horizontally. This procedure is quite effective and frequently obviates additional resection of the antagonist. The indications for this procedure as well as statistical evaluation of the results achieved with this technique are given. (3 figures, 2 tables, 6 references)

Gunter K. von Noorden.

Sanchez Agesta, Ricardo and Galvez Montes, Jose. **Monocular occlusion as a precipitating factor in concomitant strabismus.** Arch. Soc. oftal. hispano-am. **20**: 318-322, April, 1960.

Two cases are reported, in children four and five years old respectively, in whom bandaging of one eye because of a perforating injury in one of them and because of the excision of a sebacious cyst about the eye in the other, led to the development of concomitant convergent strabismus. Both children had a hyperopia of about four diopters. In one case the strabismus was corrected within one and one half years after correction of the refractive error; the strabismus was however present without the correcting glass. The author points out that in young children the fusion reflex can be easily abolished and latent strabismus become manifest. He suggests that in young children a thorough ocular examination should precede any intervention which will require occlusion of one eye.

Ray K. Daily.

Smith, J. L. and Walsh, F. B. **Opsoclonus—ataxic conjugate movements of the eyes.** A.M.A. Arch. Ophth. **64**:244-250, Aug., 1960.

Two cases of this condition are reported and those in the literature reviewed. There is a sudden onset of general malaise followed in about a week by constant chaotic eye movements, gross

in amplitude, but conjugate and not associated with diplopia. Myoclonic jerks are often present in the face, neck, trunk and extremities. The sensorium remains clear and complete recovery is usual within four months. (7 references)

Edward U. Murphy.

Stein, C. **Strabismus in the infant. A disease of guilt.** Ann. d'ocul. **193**:590-597, July, 1960.

A psychoanalytic theory of strabismus is presented. The author feels, and substantiates his thesis with numerous examples, that in many cases strabismus is an outward expression of guilt feelings of a child. This occurs sometimes as the result of parental correction and sometimes simply as a result of oedipal and sexual thoughts that the child feels are shameful in nature. The strabismus then is a sort of self-punishment for these shameful thoughts which the child believes he has. The author recognizes that treatment for the local problem must be undertaken but he emphasizes that the psychological aspects of the etiology should not be neglected. In many cases psychiatric referral will help with this entity.

David Shoch.

7

CONJUNCTIVA, CORNEA, SCLERA

Allen, J. H. and Byers, J. L. **The pathology of ocular leprosy. I. Cornea.** A.M.A. Arch. Ophth. **64**:216-220, Aug., 1960.

Opacification of corneal nerves, avascular keratitis, pannus, interstitial keratitis, and corneal lepromata are found. Transitory beading of the corneal nerves is a specific and pathognomonic sign and has its greatest value in the detection of early cases in the families of affected individuals. (3 references)

Edward U. Murphy.

Busse-Grawitz, E. G. **Conjunctivitis in oligoleucocytic animals.** Klin. Monatsbl. f. Augenh. **136**:650-657, 1960.

Leucocytic transformation of the conjunctival epithelium after instillation of a 2 percent silver nitrate solution did not occur in rabbits when the animals were treated with a sublethal dose of nitrogen mustard prior to the instillation. At the same time, however, leucocytic production in the connective tissue elsewhere in the body was not yet interfered with. It must be assumed from this observation that extraocular connective tissue maintains its defensive effectiveness longer than the conjunctival epithelial cells in cases of generalized tissue poisoning. (4 figures, 2 references) Gunter K. von Noorden.

Dohlman, C. H. and Österlin, S. **Delayed clouding in corneal grafts.** Acta ophth. **38**:242-246, 1960.

A penetrating autologous corneo-scleral graft to one eye stayed clear while a corresponding homograft to the other eye suffered a delayed clouding. This is due to a transplantation immunity reaction of the host. (2 figures, 10 references)

John J. Stern.

Fassin, W. **Report on a vasoconstrictor drug (Yxin).** Klin. Monatsbl. f. Augenh. **136**:680-682, 1960.

The author had good results with Yxin (Pfizer) in the treatment of abacterial conjunctivitis. (3 references)

Gunter K. von Noorden.

Fink, A. I., Bernstein, H. N. and Binkhorst, D. **Effect of alpha-chymotrypsin on corneal wound healing.** A.M.A. Arch. Ophth. **64**:104-107, July, 1960.

Experimental wounds were made in cats' corneas and artificially disrupted on the third day after surgery. Alpha-chymotrypsin had no effect on the tensile strength of the healing incision. (4 figures, 1 table, 11 references)

Edward U. Murphy.

Frayer, W. C. **The histopathology of perilimbal ulceration in Wegener's granulomatosis.** A.M.A. Arch. Ophth. **64**:58-64, July, 1960.

Both eyes in a fatal case were examined histologically. Occlusion of the anterior ciliary vessels by a necrotizing angiitic process produced necrosis of the sclera and marginal areas of the cornea. Granulomata were present in the ciliary bodies. (6 figures, 15 references)

Edward U. Murphy.

Fuchs, A. **Distribution of several forms of keratitis in the world. (Chapter from "Geography of Ophthalmology").** Klin. Monatsbl. f. Augenh. **136**:696-700, 1960.

On the basis of questionnaires mailed by the author to ophthalmologists all over the world, the global distribution and frequency of dendritic keratitis, ulcus serpens, and keratitis nummularis is reported. (6 references)

Gunter K. von Noorden.

Fuchs, A. **Keratomalacia and conjunctival xerosis. (Chapter from "Geography of Ophthalmology").** Klin. Monatsbl. f. Augenh. **136**:700-704, 1960.

Basing on questionnaires mailed by the author to ophthalmologists in 79 countries, the distribution and frequency of keratomalacia is reported. The etiology of this condition and some therapeutic measures are discussed. (8 references)

Gunter K. von Noorden.

Gundersen, Trygve. **Surgical treatment of bullous keratopathy.** A.M.A. Arch. Ophth. **64**:260-267, Aug., 1960.

All of Bowman's membrane and most of the stroma except over the pupil were removed and the excised portion of the cornea covered permanently by a conjunctival flap. It was hoped that dehydration and clearing of the central area would occur after this procedure. Twelve eyes were treated in this manner and although pain was relieved regularly, vision was usually not improved. (8 figures, 1 table, 2 references)

Edward U. Murphy.

Hogan, M. J., and Goodner, E. K. **Surgical treatment of epithelial cysts of the anterior chamber.** A.M.A. Arch. Ophth. **64**:286-291, Aug., 1960.

The clinical course and pathogenesis of epithelial cysts are discussed. Six cases were treated by aspiration and diathermy coagulation. Four were cured, one required surgical excision after two recurrences, and one has not been followed long enough as yet. (1 figure, 9 references)

Edward U. Murphy.

Jensen, O. A. **Arcus corneae in young individuals.** Arch. d'opht. **20**:154-161, March, 1960.

The author reviews the literature and notes that arcus corneae is rare in patients under 20 years of age and that the youngest case reported was in a child ten years of age. Jensen has observed the phenomenon in three children (11, 12, and 16-years-old respectively) belonging to two families showing hypercholesterolemia. The cases and families are described in detail with genealogical tables. In his discussion the author stresses that arcus of the young and of the old differ not only in their location but in their origin: in arcus senilis, lipoidal deposition occurs in an abnormal cornea, whereas in the young the arcus is associated with pathologically altered serum lipoids with infiltration into a normal cornea. Cholesterol appears to be the lipoidal fraction responsible for the condition. (3 figures, 29 references)

P. Thygeson.

Juncedo Avello, J. and Rodriguez Alvarez, M. **A case of crystalline corneal dystrophy.** Arch. Soc. oftal. hispano-am. **20**: 331-335, April, 1960.

This is a report of a case of a primary bilateral crystalline corneal dystrophy in

a 14-year-old boy in whom no other clinical or metabolic changes could be found. A hereditary factor was not elicited in the history. The impaired visual acuity, particularly of the left eye was discovered during a routine school examination. The ocular examination of the left eye revealed the presence of an annular corneal opacity, with a clear center and a clear intermediate zone between the opacity and the limbus. Corneal sensitivity was slightly reduced in the center of the cornea, and there was a slight photophobia. Under the biomicroscope the infiltration was seen to consist of a delicate wreath of yellowish crystals in the corneal parenchyma. Therapy with Edta, and a fat free diet, vasodilators and vitamin B-15 was without effect. The nature of the crystals is discussed, and the author, because of the morphology of the crystals and their color, inclines to the belief that they are lipoid in nature, in spite of the fact that a disturbance in the fat metabolism of the patient could not be demonstrated. (2 figures) Ray K. Daily.

Khralachev, V. **Certain trophic changes of the cornea.** Vestnik oftal. **4**:16-21, July-Aug., 1959.

Neurotrophic disturbances of the cornea are noted in experimental section of the trigeminal nerve, as well as in traumatic injuries of the nerve in fractures at the base of the skull. The clinical picture in the cornea resembles the kerato-malacia of avitaminosis A. Two patients were observed, one with xerosis, the other with fracture of the base of the skull. The keratitis in the latter was reminiscent of keratomalacia. (6 references)

Victor Goodside.

Lansche, R. K. and Lee, R. C. **Acute complications from present day corneal contact lenses.** A.M.A. Arch. Ophth. **64**: 275-285, Aug., 1960.

Fourteen cases of acute corneal damage by contact lenses were observed, including punctate central keratitis, superficial erosion, and full-thickness epithelial abrasions. All patients recovered normal vision after treatment and there was no scarring. The problems arising from the wearing of such lenses are discussed. (10 references) Edward U. Murphy.

Lorentzen, S. E. **Keratoconjunctivitis sicca in sarcoidosis.** Acta ophth. **38**:235-241, 1960.

Two post-menopausal women with pulmonary sarcoidosis showed keratoconjunctivitis sicca. The pathogenesis is discussed. (16 references)

John J. Stern.

McMeel, J. and Wood, R. **Active Immunization against psuedomonas infection of the cornea.** Tr. Am. Acad. Ophth. **64**:490-492, July-Aug., 1960.

Fourteen control eyes showed severe infection, whereas 27 of 32 eyes in rabbits actively immunized with Pseudomonas aeruginosa vaccine were completely protected. Only one eye had a severe infection. (1 table, 11 references)

Harry Horwich.

McMeel, J. and Wood, R. **Passive immunization against pseudomonas infection of the cornea.** Tr. Am. Acad. Ophth. **64**:486-490, July-Aug., 1960.

Pseudomonas-immune gamma globulin in 70 to 140 mg. dosage given 48 hours prior to challenge was completely protective against infection in 24 rabbits. This is interesting in view of the avascularity of the cornea. (3 figures, 2 tables, 1 reference) Harry Horwich.

Ribas Bensusan, Jose. **Disciform keratitis caused by smallpox.** Arch. Soc. oftal. hispano-am. **20**:329-330, April, 1960.

Several days after vaccination a woman who rubbed her eyes because of a nervous temperament developed vesicles on the

left lids. About the same time the left eye was scratched by an olive leaf, while she was working, which produced an acutely inflamed eye. On examination she was found to have dry vesicles of the lids, an acute iridocyclitis, corneal anesthesia and a superficial corneal axial infiltration. In spite of therapy the corneal process proceeded to develop into a disciform keratitis. The infection is considered exogenous in nature but an endogenous factor can not be altogether eliminated, since the patient's vaccination was followed by fever indicating a generalized spread of the virus. It is possible that the corneal trauma produced a focus of low resistance for an endogenous invasion of the virus. (1 figure) Ray K. Daily.

Sabadeanu, V. and Szeremy, M. **Contribution to the study of petrifying conjunctivitis.** Arch. d'opht. **20**:162-170, March, 1960.

Since Leber's original description of this entity in 1875, only a few reports of it have appeared. Some authors have regarded the entity as a primary condition while others have considered it to be secondary to trauma, to chemical burns, or to automutilation in psychopathic individuals. The authors describe an example of the condition in a young female peasant in whom the left eye presented the typical conjunctival picture with numerous concretions, as described by Leber. General physical examination was negative. Biopsy examination revealed numerous concretions in a rich granulation tissue beneath the epithelium. Histochemical examination showed the concretions to be composed of calcium phosphate and calcium carbonate. In addition to the conjunctival changes there was a corneal nodule composed of minute concretions. The authors speculate on the pathogenesis of the condition and suggest that it is due to local nonspecific conjunctival disease in the presence of an elevated blood-calcium level. They consider "calcifying conjunctivitis" a more appropriate name for the condition. (5 figures)

P. Thygeson.

Vannas, S. and Teir, H. **Observations on structures and age changes in the human sclera.** Acta ophth. **38**:268-279, 1960.

Thirty-three eyes of persons of different ages were examined. The lead acetate-mercuric chloride Mallory technique showed that the red-staining diminished with age, particularly in the drainage area of the anterior portion of the sclera. Unusual fibers and perpendicular tubular structures became more conspicuous. The structure became looser and more porous in drainage areas and near the exit veins. Acid mucopolysaccharides were concentrated in the inner portion of the sclera back from the scleral spur and in the outer layers extending to the episclera. (6 figures, 39 references) John J. Stern.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Hallett, J. W., Wolkowicz, M. I, Leopold, I. H. and Wijewski, E. **Latex agglutination test in uveitis.** A.M.A. Arch. Ophth. **64**:133-134, July, 1960.

With added gamma globulin, uniform size polystyrene latex particles can be used in agglutination tests for rheumatoid arthritis. This was done in 151 cases of endogenous uveitis but was not found to be helpful in the diagnostic work-up. There was a high number of false positives and the diagnosis of arthritis was usually clinically obvious. (7 references)

Edward U. Murphy.

Oksala, A. **Rheumatoid arthritis, spondylarthritis ankylopoietica and focal infections in acute anterior uveitis. Their incidence, effect on the sedimentation rate and duration of treatment.** Acta ophth. **38**:322-329, 1960.

In a series of 386 cases of acute anterior uveitis, rheumatic arthritis occurred in 14 percent and spondylarthritis ankylopoetica in 15 percent; foci were not found in 31 percent. The sedimentation rate was significantly higher in the groups with uveitis plus rheumatoid arthritis and uveitis plus spondylarthritis than in those with uveitis with or without a focus of inflammation. The group of uveitis plus an inflammatory focus had to be treated longer than that without such a focus. The clearing up of the foci did not reduce the duration of treatment. Foci are considered to play only a small role in the etiology of uveitis. Acute anterior uveitis is a more extensive disease involving the whole organism. (3 tables, 37 references) John J. Stern.

9

GLAUCOMA AND OCULAR TENSION

Aulhorn, E. and Harms, H. **The correlation between disc and field changes in glaucoma.** Ophthalmologica **139**:279-285, March-April, 1960.

In a large series of frank glaucomas and glaucoma suspects one of the authors studied and recorded photographically the ophthalmoscopic appearance of the retinal vessels and of the disc, paying special attention to shape, size and location of the excavation and to the color of the nerve fiber tissue on the disc. Independently and without knowledge of the ophthalmoscopic findings the other author made detailed studies of the visual fields.

In 53 out of 74 eyes corresponding field and disc findings were obtained, that is the portion of the disc which appeared atrophic or selectively excavated, corresponded to the damaged portion of the visual field. Marked narrowing of the retinal arterioles, either on or close to the disc, was found in 50 percent of the cases with noncorresponding disc and field damage and only in about 25 percent of the cases with corresponding field and disc damage.

Fundus photographs do not record all the fine details that the ophthalmologist can discern with the ophthalmoscope. (4 figures, 2 tables) Peter C. Kronfeld.

Curschmann, V. **Etiological and therapeutic observations in glaucomato-cyclitic crises.** Klin. Monatsbl. f. Augenh. **136**: 678-680, 1960.

Three patients were observed, one of whom had heterochromia. All patients had a similar constitution and seemed to be vegetatively unbalanced. General sedation combined with cortisone and diamox caused the attacks to subside within three to five days. (14 references)

Gunter K. von Noorden.

De Almeida, A. **Malignant glaucoma.** Arq. brasil. de oftal. **23**:1-6, 1960.

Malignant glaucoma is defined as that increase in ocular tension which appears after an antiglaucoma operation and is characterized by the absence or near absence of the anterior chamber with forward displacement of the crystalline lens. It may follow any type of glaucoma surgery—iridectomy, cyclodialysis or a fistulizing procedure. It occurs more often in patients with hyperopia who have a relatively large lens. It should not be confused with other types of secondary glaucoma or glaucoma capsulare.

The mechanism of action in the increased tension seems to be a forward displacement of a large crystalline lens which may be intumescent. Pupillary block results along with a closure of the angle of the anterior chamber. The treatment of choice is prompt extraction of the lens.

Several illustrative case histories are presented. (5 references)

James W. Brennan.

NEWS ITEMS

Deaths

Dr. Lowell Privett, Boise, Idaho, died June 13, 1960, aged 59 years.

Dr. Henry G. Wincor, New York, New York, died July 17, 1960, aged 74 years.

Dr. Maurice C. Landau, Glens Falls, New York, died September 14, 1960, aged 50 years.

Announcements

Saturday morning lectures

The Department of Ophthalmology of the Washington Hospital Center, Washington, D.C., offers a three-year curriculum of Saturday morning lectures, one year being devoted to the basic sciences and the other two years to clinical subjects. These lectures are designed for training the resident staff in ophthalmology and in preparation for Board examinations.

Special lectures by outstanding authorities in their fields of chief interest are given in the School of Nursing auditorium beginning at 9:30 A.M. and terminating at 12:00 NOON. All physicians are invited to attend the entire course or any individual lectures. There are no fees for attendance. An attendance record can be provided to residents from other hospitals, if such is desired for training credits. The series is partly financed by a grant from the Guild of Prescription Opticians of metropolitan Washington.

The program for October, November, December, 1960, and January, 1961, includes: October 29th, "Rambles in neuro-ophthalmology," Dr. Frank B. Walsh, Baltimore. November 5th, "The normal and abnormal pupil," Dr. Robert E. duPrey. November 12th, "Papilledema, papillitis and retrobulbar neuritis," Dr. William B. Glew. November 19th, "Chiasmal and suprachiasmal lesions," Dr. Melvin G. Alper. November 26th, "Neurosurgical-ophthalmological problems," Dr. Hugo V. Rizzoli.

December 3rd, "Headaches, migraine, epilepsy, EEG," Dr. Harold Stevens. December 10th, "Lesions of the circle of Willis and the phakomatoses," Dr. Melvin G. Alper. December 17th, "Nystagmus and visual field studies," Dr. C. Wilbur Rucker, Rochester, Minnesota. Because of the Christmas holidays, there will be no meetings on December 24th and 31st.

The January, 1961, program includes: January 7th, "Physiologic optics," Dr. Arthur Linksz, New York. January 14th, "Physiologic optics," Dr. Ben S. Fine; "Geometric optics," Dr. William H. Seward. January 21st, "Biologic optics," Dr. Joachim A. Kluger; "Geometric optics," Dr. William H. Seward. January 28th, "Physiologic optics," Dr. Everett S. Caldemeyer; "Refraction," Dr. James B. Bain.

Miscellaneous

Sitapur Eye Hospital

Any ophthalmologist who would like to take advantage of the clinical material available at the Eye Hospital, Sitapur, U.P., India, should correspond with the Chief Medical Officer of that institution. The hospital has 450 beds, an out-patient load of 37,741 (1959), in-patients, 10,257 (1959). During 1959, 4,555 cataract operations were performed and other operations (strabismus, retinal detachment, keratoplasties, and so forth) totaled 13,555.

Dedication program

The dedication program for the University of Kentucky Medical Center and Medical Center Library, Lexington, Kentucky, was held on September 23rd and 24th. Among the speakers were the Honorable Bert T. Combs, Governor of Kentucky, and Prof. Rene J. Dubos of the Rockefeller Institute.

Societies

Instituto Penido Burnier

Officers for 1960-1961 of the Medical Association of the Penido Burnier Institute, Campinas, are: President, Dr. Alfredo Martinelli; first secretary, Dr. Roberto Pimentel; second secretary, Dr. Manoel Abreu; treasurer, Dr. L. de Souza Queiroz; editorial committee for the *Arquivos*, Drs. Antonio de Almeida, Gabriel Porto, and R. Franco do Amaral.

Brooklyn program

The following problem will be presented at the Monday, November 28th, meeting of the Brooklyn Ophthalmological Society: "The Brooklyn-Queens glaucoma survey, May, 1960: Methods and data," Dr. Bernard Schwartz; "Follow-up of suspect glaucoma patients," Dr. Samuel Minowitz, Borough Director of Health Services. "Acute angle-closure glaucoma," Drs. Joseph T. Menaker and Bernard Schwartz. "The diagnosis of glaucoma," Dr. W. S. Knighton, assistant clinical professor, Columbia-Presbyterian Hospital, New York City.

Long Island society

Dr. Herman Krieger Goldberg, assistant professor, Wilmer Institute, The Johns Hopkins University, discussed "The reading problem" at the October meeting of the Long Island Ophthalmological Society which was held for the school personnel of Long Island at the Nassau Academy of Medicine, Garden City, New York. Officers of the society are: President, Dr. Jesse J. Michaelson; vice president, Dr. John R. Roche; secretary-treasurer, Dr. William L. Donnelly; assistant secretary-treasurer, Dr. Gerald M. Branower; members of the council, Dr. Harry McGrath and Dr. Arthur E. Merz.

Personal

The appointment of Dr. Irving Henry Leopold as professor of ophthalmology in The Johns Hopkins University School of Medicine has been announced by Milton S. Eisenhower, president of the university. Dr. Leopold comes to Johns Hopkins from the University of Pennsylvania Graduate School of Medicine and will assume his new position on January 1, 1961.

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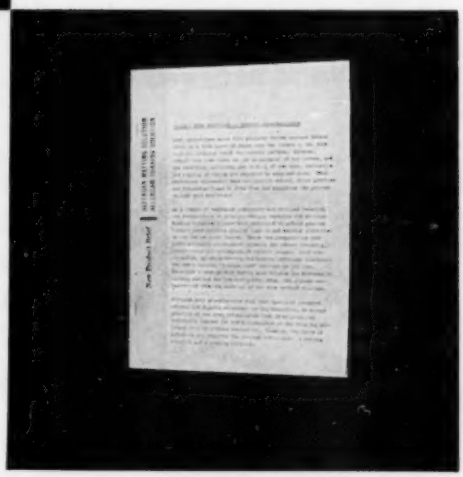

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